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The Engineer as an Economist.

AN ADDRESS GIVEN AT THE COMMENCEMENT EXERCISES OF THE THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY, POTSDAM, N. Y.,

June 9, 1905,

BY

C. J. H. WOODBURY, A.M.

Boston, Mass.

The personal reminiscences inspired by a commencement blend into those of historical retrospect, whose last chapter is of to-day, and whose relations to the proximate future rest upon the developments of past time.

Forty centuries look down upon each of us day by day as much as they did upon the legions of Napoleon at the battle of the Pyramids; and we in turn must depend upon the forty centuries for the heritage of enlightened civilization, which, in its ever-widening course from the Orient, along the northern littoral of the Mediterranean, swept over Europe, receiving year by year from nation after nation an enduring contributionship of whatsoever may serve as a beneficence to the greater number of mankind.

The endowments of life have been extended from the few to the many, to whom the luxuries of one generation have continued to become the proverbial necessities of the next, for generation after generation, until there is a demand for more in food, clothing, habitation and the ameliorations of existence beyond what is necessary to support life for the time being.

Famine and pestilence are now of barbarism, better nourishment has doubled the average span of life since the middle ages, and within the last century the senility of the seventh age of man has been postponed half a score of years.

This change for the better requires more than the dynamic force of the individual can produce, and this deficiency of initial might is supplied in civilized countries from the service of machinery, the segregation of skilled artisanship, and the utilization of products of lower civilizations where conditions of life are simpler, under the indulgences of more generous nature.

To supply these advantageous conditions in modes of life requires a concentration of the resources of the whole world, as well as application of the combined skill of enlightened mankind.

These blessings have been vouchsafed upon humanity as a result of the work of the engineer, whatever may have been the title now given to him who can build better than a layman.

From the Aryan migration, when the member of a moving colony who could bridge streams was the leader, and this term of the greatest bridge builder became fixed in language as a supreme title which Roman emperors took from their priesthood, and surviving that dynasty, Pontifex Maximus has since been conferred upon the head of the See at Rome.

In its secular phrase the title of engineer has been an honorable one, indicating an occupation in the forefront of civilization, ministering to the weal of humanity.

Like many towns in the old countries, the world's history is a succession of groups of events, each collection having a common purpose to build anew from old material. Each epoch in this development of material resources has been marked by some trend of improvement in thought and action which has been instrumental to the enlightenment of to-day.

It may be worth the while to cite several of the best known of these steps, which appear to have been especially contributory to the establishment of conditions requiring the work of the engineer in its application to the general welfare.

Beginning with the individual unit, Christianity, through its propaganda among the Roman trade unions, which were far more closely organized than their successors of to-day, inspired the lowly with the communistic heresy that every man had a soul, at a time when even the most advanced Greek philosophy limited immortality to the aristocracy ; and by the inculcation of the Jewish Sabbath, it provided for work at higher efficiency during the six days.

These principles went further than the outward church, even as they have encompassed the whole world to-day, and were doubtless the cause of the remarkable revival throughout Roman polytheism in the year 200, when the various deities were relegated virtually to saintships, with an ethical head pre-eminent over all.

The next step was the downfall of the Roman empire, through the excessive taxation which was necessary to support that great centralization of power, at the time when its internal strength was impaired by slavery diffused throughout the empire to such an extent that every Roman was surrounded by those ready to become enemies the moment that opportunity afforded.

This slavery was not confined to unskilled labor and menial services, but reached to the highest classes of artisanship, and even the professions, particularly that of medicine.

But this downfall did not occur until the Romans had established a system of law which provided a defence for every individual in all his relations of person and property.

While it has been said that peace hath her victories no less than war, it is a fact that the records of wars are better known than the modest activities of peace. The invaders of Rome were too few to materially change the population, and gave the people that liberty which is merely the change of one despot for another. The Roman law survived conquests, and in every conquest the defeated party gains victories by imposing its customs upon the victors.

The magnitude of the great work of the Roman government in the establishment of its law and in its dissemination

throughout Europe, where it remained after the fall of the empire, is marked by the fact that these laws were continued by the conquerors in the Latin language, and through this means the principles of the Romans were maintained throughout Europe, and became a heritage of civilization unto the present day.

The dark ages represented the time necessary to reorganize civilization from the degeneration of skilled labor, resulting from the economic fallacy of slavery, which was all the more pernicious on account of the high class of the bondsmen; and, while attention is often called to the fact that learning was almost entirely possessed by the clergy, yet it is often overlooked that the strength of the church was due to the fact that it was recruited by the principle of selection from fresh blood, and not continued by inheritance, and that it required generations of efforts of the monks to establish the character of honest manual labor.

The cultivation of land under serfdom was so inefficient that relatively large areas were required, and the population increased so rapidly in the absence of great wars, that it became so congested in Germany that every sixth year one man in six was selected by lot and expatriated, to "go to a place he wot not of."

Information of other countries, both as to product and demand, is not merely advantageous, but an essential preliminary to the exercise of that barter which constitutes foreign trade; and this knowledge was obtained by the Crusaders, who gained the education of travel, and their retreat brought into Europe oriental goods, tropical products and ideas of luxury.

The lessons were not always pleasant ones; one of the most notable being that of Montgolfier, the French knight, who was taken prisoner by the Saracens and sold into slavery to the Moors, who kept him at labor in their paper mills at Bagdad, where he toiled for many years; and on his return to his home in southern France he established paper making in Europe in mills which are still operated by his descendants, who gave to the world the pioneer aeronaut of that name.

The Saracens still held their dearly bought victories in remembrance, and were averse to the trespass of foreign caravans on their territories for trade with the Franks.

Then began the mania for exploration by the maritime nations, eager for trade with the Indies, and pushed by the crowded condition at home of those eager for conquest and colonization.

These developments were slow, but never retrogressive, and prepared the nations for continual advance, which called for new methods.

The services of the engineer were thus required for the output of industry to distant countries and the return of the luxuries of the fertile tropics, the maintenance of congested communities in health, and the better protection of the person by adequate clothing.

The prevailing direction of the work of the modern engineer has trended towards applications to the welfare of private individuals rather than to that of the government, especially in its military relations.

Life has been extended and health improved in the congestion of cities largely by the general installation of systems of water supply and sewerage; while, in the further concentration of employment, forced ventilation has rendered mines healthy and made the modern crowded office building a sanatorium, and in like manner added to the efficiency of the labors of the occupants.

Artificial refrigeration is a marked instance of the economy of engineering science applied to the general welfare, in its frugal checking of waste and its extension of the variety as well as improvement in food supplies.

An early indication of the segregation of industry into manufacturing appears to have been the separation of cloth making from the household to what eventually became a mill, where the production of this new industry made clothing more abundant because of its lesser cost, until there was a surplus.

Invention has followed invention until the contributionship of machinery has reduced the cost of the product.

The first mill in the world where cotton was converted into finished goods exclusively by machinery driven by power was at Waltham, Mass., where a certain grade of sheeting, costing in 1816 30 cents a yard, has since been sold at 4¾ cents a yard.

The hours of labor have diminished nearly one-third, and the daily wages have increased enormously.

The amount of mental force applied to these engineering problems is beyond conception, as their results transcend estimate.

It has raised millions of employees above what might have otherwise continued to be virtually conditions of serfdom.

It has better clothed millions of human beings, and yet human toil is so cheap in the less favored countries that three-quarters of the people of the world wearing cotton goods are believed to use hand-spun cloth; for the products of cotton mills which are sent to the Orient and the tropics do not penetrate far from lines of water transportation, the commercial limit of land transportation being in many instances only fifty miles, where these goods equal the competition of hand labor.

In woolens the rate of improvement has been comparable, except that the relative cost of the raw material forms a so much larger proportion of the finished product that the final differences are not so marked in degree.

Yet two instances will indicate the nature of the improvement.

The general use of carpets is the result of the power loom, and yet they were so rare in a former generation that when Dr. Lyman Beecher had a hand-made carpet, which was presented by a relative, one of his deacons seriously asked, "Brother Beecher, do you expect to have all this worldly vanity and the ineffable joys of Heaven besides?"

The first cost of the stock has been modified by the utilization of woolen cloth as a raw material, which has permitted the cheaper production of warmer clothing; although shoddy has a bad name, it enters into the composition of the finest broadcloth.

Many of the handicrafts made as good work by hand as is now produced by machinery.

The finest cotton goods in the world are still hand spun in India, the Gobelin tapestries are still incomparable, medieval textures furnish the inspiration for design of the fabrics of to-day; and printing was from the first equal to modern standards.

I have a "horned" Bible (so called from an error in cornuatum for coronatum in Exodus XXXIV), which is well printed on good paper, gilt edges, and bound with spring back, yet it is stated to have cost in its day an amount equal to fifteen years' wages of a laborer; and, being in Latin, few except the clergy could read it.

The essential element of the prosperity of our civilization has been the development of both internal and foreign communication, which brought forth the fundamental inventions and the methods of construction necessary for the establishment of steam navigation and the steam railway as channels for commerce.

One should not be too boastful to claim that an invention has reached the highest possible development, lest he should repeat the history of a United States patent examiner in 1836, who felt so sure, from the opportunities of his position, that the resources of the human mind had been exhausted by invention, that he was one of the few Federal officials who voluntarily resigned their positions; and he resumed his old profession of portrait painting, where he was sure of a livelihood as long as vanity and solvency existed in the same individual.

Fundamental pioneer engineering work has been done for so long and to such an extent that the constructive problems have been solved; both principles and methods have been set forth in numerous books, giving every phase of engineering experience of the past, followed by the engineering journals of to-day, so that the precedents are matters of accessible record, whose technical principles may be applied by any one possessed with the essential training in the apprenticeship of the subject, although the commercial relations, now as always, require an experienced mind.

Solutions of constructive problems have revealed others, and within a few years the centre of engineering skill has shifted like a whirlwind to meet the new issues.

The wider insistence for the luxuries of civilization has made them a necessity, and these betterments must be supplied to a greater number; and in the same spirit there is a demand for a reduction of the time of labor; therefore, to meet these conditions costs of operation must be reduced, and the efficiency of productive methods increased.

The highest problem of the engineer has ceased to be how to do things, for that is well known, but it is how to do them cheaply; the problems are fundamentally those of economics.

When the application of steam to ocean transportation became possible it was at once demanded by the governments, in order to establish quicker means of communication with colonies, and also the use of the mails for the development of closer commercial relations, years before it was thought possible that steam navigation could be used exclusively for freights.

The side-wheel boats, with engines using steam at fifteen pounds pressure, required so much space for engine, boilers and fuel as to warrant the prophecy that a steamer could not cross the Atlantic, had it not been for the reinforcement of sails in these fully rigged steamships.

Once that ocean steam navigation was initiated, then came the economical applications of engineering for the reduction of expenses, and resulting in the wider use of steam vessels, and for longer voyages.

Remembering that every saving of weight and space devoted to machinery and coal gives a similar accommodation for cargo, the combined result of the substitution of propeller for side wheels, high-pressure steam, compound engines, the use of steel in place of iron, and redesigning of the lines taken from sailing vessels to those suited for iron steamships, the aggregate economies have reached to the enormous extent that the combustion of a ton of coal now transports across the Atlantic over fifty times as much cargo as fifty years ago; and the mercantile world is awaiting with interest the result of the

renaissance of the original rotary engine in its modern application in the form of the steam turbine for the propulsion of vessels.

The highest type of engineering economies has not been applied to the ocean greyhounds, but in the less conspicuous freight steamers of moderate speed and large size, where the question of interest on the property in transit has been an element in the problem of speed; equating between the two in order to obtain minimum cost, less speed consumes a smaller amount of coal, greater speed secures a smaller interest charge on the trip. These economies have been developed until the aggregate result is expressed by the fact that there are many vessels in which the combustion of a pound of coal will propel a ton of cargo and its share of the vessel eleven and two-thirds miles.

In more commercial terms, freight has been transported across the Atlantic for 56 cents a ton; or to apply the change to the comparatively recent development of ore deposits at the Lake Superior region, the cost of transportation of ore through the lakes from Superior to Erie has diminished from $3 to 55 cents a ton.

These figures include terminal charges for loading and discharge, in which the engineer has applied his skill in the economic handling of material, particularly that which is in bulk. Ores, coal and grain are handled by methods adapted to each material; while the huge grain elevators, built with the wisdom of a modern Joseph, forfend cities and nations against famines which would otherwise threaten them.

These new conditions of water transportation have provided for increased tonnage, both as to single cargoes and the additional number of voyages by greater speed of transit; and this serves as an illustration of the results of engineering economies established through the concentration of units.

For the purposes of comparison, it was recently desired to obtain a photograph of a harbor in a large eastern seaport, to compare with an old ambrotype from the same point of view; and it was found that it was impossible to select a time when

there was a number of boats in the field of the camera equal to those shown in the early picture; and examination of statistics revealed that, while the tonnage of the freights at this port had increased in quantity, the number of vessels had diminished.

Since the introduction of steam navigation the Lloyds and other marine underwriters have had in their service the ablest of steam engineers; but the great business of fire underwriting remained a clerical occupation, betting against the chance of fire, until less than a generation ago, when the profession of insurance engineering was established to apply scientific methods to the measure of existing hazards, and, beyond that, for the initiation of means for the diminution of the occurrence of fires, the reduction of loss by efficient apparatus, and the resistance to flames by suitable construction.

On the principle that it is cheaper to prevent a fire than to pay a loss, insurance companies all over the country place at the service of their clients engineers who will give professional services upon the construction of buildings, organization of fire-extinguishing equipment, installation of lighting apparatus, and even to details of lubrication and the operation of machinery.

Through corporate management in similar lines the English have developed, by their engineers, economies in the generation and utilization of steam for operation of mills, which accomplished results far superior to those in this country until within recent years, when the precedents did service to good designers who were also good copyists.

Boiler insurance companies in this country also furnish to their clients expert service in the design of steam plant for economy of fuel as well as security.

The engineering problem of to-day is a financial problem; it is not merely to build and to operate, for both are common knowledge in regard to almost every type of work, but it is how to build with lowest reasonable conditions of annual cost of the investment, and how to operate with lowest reasonable conditions of annual expenditure; and neither of these prob-

lems may require the fewest dollars, but perhaps demand amounts beyond the dreams of avarice.

Depreciation from wear and tear forces itself into engineering problems as surely as human mortality into actuarial work; and, beyond this, the iconoclasm of sudden impairment from subsequent invention in the unknown future threatens like a sword of Damocles.

As a simple instance of an engineering problem in economics, take that of the pipe from a large pump to deliver a certain number of gallons a day into a reservoir.

The cost of such pipes of several diameters laid in the trench may readily be estimated, and the annual charge of interest and depreciation ascertained, also the annual interest on the cost of excavating and filling the trench; these items would give the annual cost of installation of pipes of several diameters, which would be clearly the least with the smallest pipe.

The other element is that of the annual cost of pumping the water, which would be the greatest with the smallest pipe and the least with the pipe of the largest diameter, on account of the lesser friction with the larger pipes.

While this data might be equated and the minimum solved by the calculus, the average engineer is generally far enough from his school days to plot the two sets of data on cross-section paper, the one above the other, and quickly determine the result graphically from the curve with far more accuracy than that of the formula from which was computed the friction of the water forced through the pipe.

This pipe problem suggests another occurrence which is frequent in engineering work. The pipe may leak, but it may cost less to suffer the waste by leakage than to excavate and repair; there are many leaks which are lesser evils.

It is trite to mention that, in commercial affairs, successful results are dependent upon accurate forecasts of the future.

The one who correctly estimates whether present events will cause market prices to rise or fall is able to buy in the cheaper and sell in the dearer market.

But the responsibility of judging futurity is more exacting

upon the engineer, for while the merchant may be able to close the transaction in case of error in judgment, and to protect himself by escaping with slight loss, instead of awaiting the finality of a larger one, the permanency of engineering work does not permit any escape from the ruthless logic of events, and work once begun must be carried to completion.

Some economies are those of the future and not of the present; as lumbering is now conducted under the supervision of the most efficient combination of technical skill and practical experience, and the woodmen who spare the smaller trees, looking ahead for the provision of another crop of the same species perhaps seventy years hence, instead of making a devastation and calling it industry, obtain less from the forest to-day, but more is expected as a permanent return on the capital.

The decadence of nations resulting from the denudation of forest districts presents some of the most deplorable instances in history, as is shown by the results in Palestine and in Spain. On the other hand, the great work of engineers in the development of fertility by irrigation and the arboreal growth which follows it in the western part of this country have warranted plans for the further extension of this work over the nine hundred thousand square miles of territory which are available for the purpose; and it may be expected throughout these enormous tracts that the words of the prophet will come to pass, in that "the desert shall rejoice and blossom as the rose."

On the northern shore of Massachusetts Bay the peninsula of Nahant juts out into the sea, forming by its natural contour one of the most picturesque points on the Atlantic coast. After the Puritans purchased this tract from the Indians for a jewsharp, two hundred and seventy-five years ago, it was subdivided among the settlers of the adjacent mainland, on the condition that each holder should fell all of the forest trees upon his allotment within six years, as a condition of acquiring title to his share; the purpose being to convert the peninsula into a large grazing tract, which could be easily defended against bears and wolves by a watch which was kept night and

day on the isthmus. Following the removal of the trees, this land soon became sterile, and was used only for a few fishing huts until about seventy-five years ago, when a retired man in affluent circumstances purchased a large quantity, and accomplished the reclamation of this beautiful spot by planting trees.

The regularity of operation is an important element in the productive work of a machine whose economy may be reduced by intermittent operation; but, in any event, fixed charges of rent, interest, depreciation from subsequent invention, and even to a certain extent the impairment of time, are essential considerations.

For example, it is ordinarily cheaper to drive piles by machinery than by hand; and yet there are occasional instances where small amounts of work are to be done in places difficult of access, where it is necessary for the gang of men to work intermittently, either in moving the piles to their site or changing the position of machinery; and then, instead of waiting while the piles are driven by power, they may be employed in raising the hammer by the direct pull of a number of men, after the manner in which this work was done years ago.

A consideration of a steam engine plant solely on the basis of the cost of fuel would be short-sighted and extravagant, because those engines which are more economical in fuel are of a greater first cost, which will render the final results frequently excessive for irregular work.

In the case of a manufacturing establishment operated by water wheels, it frequently becomes necessary that provision be made for supplementary power, to be available during periods of drought; and it is a matter of simple estimate and computation to determine the class of steam power plant preferable for any conditions of affairs wherein the annual use of the engine may be an estimated factor, and the final results for a plant operating perhaps six weeks in the year may warrant only a cheaper type of steam engine and boiler, wasteful as to fuel, but economical as to its first cost and depreciation. On the other hand, if the steam from these boilers may be used advan-

tageously for heating during a certain portion of the year, or for bleaching or dyeing continuously, this element of the problem may be modified; and if proposed extensions to the establishment in the near future will require a more extended use of this supplementary power, another element will be introduced into the problem which may warrant a more expensive plant, of the highest degree of steam economy.

In lubrication it frequently is advantageous to use greater quantities of oil for the reduction in the power cost. It required many years for the textile interests to learn that free lubrication of spindles was more economical than a limitation in the quantity of oil, which lubricated, but with greater friction; yet this may not be accepted as a truism, as it is modified by the cost of power, whether it be from steam and measured by shovelfuls of coal, or whether from an ample water power, where the cost is not increased by raising the gate.

A manufacturer of an article by a chemical process in general domestic use, which made a competitive product not protected by either patents or by the tariff, believing that it would be advantageous to introduce technical skill in the works, employed a professor of chemistry from a leading college, and was surprised that the professor did not give any attention to the main process, but began the most critical examination of the waste products, from which a number of substances of great value were obtained.

Railway transportation could not be established until the development of manufacturing stimulated the output of mines, and the necessity for their transportation and that of raw material and finished goods required cheaper means for moving these products in large quantities.

Steam transportation has not supplanted the need for horses, as was anticipated by the farmers who were impelled for that reason to make such attacks upon the surveying parties for the early English railways that pugilists were employed to pose as the head of the parties, and to strike from the shoulder when the protests became more than verbal.

Great as may be the amounts of material transported by railway, all of it, excepting that for export, is teamed at least twice, and much of it more than twice.

It appears as if the lessons of the Romans in highway building had been ignored in this country, and that the cost of tributary transportation by team was unnecessarily excessive; although the problem of minimum cost must be equated between the annual expense of a good highway and the amount of teaming which it bears.

For example, in lumbering it would not be warrantable to build any more of a highway than a cleared strip through the forest, where temporary snow roads may be made in winter.

The type of pioneer engineering to devise and build a railway has passed away, and its contributions of precedents in the construction of road bed and rolling stock have become formulated and organized, so that when a railway is to be built and put into operation every occurrence can be foreseen and due provision made.

For the maintenance and operation of the line there is constant need of the economies of engineering in the systematic methods of providing for every emergency tending to impair the continuity of service, in the application of every degree of labor and material; to avoid the wastes of duplication, when to provide temporarily and when to build permanently are problems of modern engineering.

The development continued until the speed of passenger traffic approached the safe limit of centrifugal force of chilled iron car wheels, and then the introduction of steel-tired car wheels enabled the further augmentation of speed.

The power of the railway influence was indicated a few years ago, when, like a Joshua, it changed the standards of time, and not only schedules of train service, but the goings out and comings in of the whole people conformed to the new conditions.

Moreover, be it remembered that this act, like others on the part of those made conservative by great responsibilities, pro-

vided for ameliorations in the infinite variety of affairs, fron the uniformity of a day's labor in factories up to contracts of the greatest magnitude.

It is not possible to consider one great development withou also meeting the tributaries which it has called into being; an the immense engineering operation of the railway system wa undoubtedly the cause of the demand for watches, which mus be produced at low cost; and the wonderful mechanica engineering work which manufactured the American auto matic machine-made watch is one of the modern triumphs of engineering economies.

To such an extent has this type of automatic machiner been developed that a factory devoted to the manufacture of cheap but quite regular watches produces four watches a da for each employee, including everybody engaged in the servic of the establishment in any capacity whatever, even the team sters and night watchmen; and the price at which some ver cheap watches are sold indicates a still larger rate of produc tion.

Vast as may be the output of watches, their use is largel confined to those within easy range of railroad transportation It is the need for their use, and not their cost, that makes th demand for watches, for no one need be prevented by cos from owning a watch of some grade.

The cry of modern life, like that of the dying Quee Elizabeth, "Millions for a moment of time," has been fulfille by the telegraph, sending its messages across continents an beneath seas to the uttermost parts of the earth; and by th telephone, which provides a path for the personal usage an its rebounding answer, which furnishes that conference need ful for every commercial transaction. It bestows more tha a saving in time; it makes a creation of results.

How much the potentiality of the individual is increased b these means is beyond the ken of those whom it serves statistics cannot enumerate its economy, nor flight of fanc portray its results.

A few years ago enormous expenditures were required t

double the wires and make corresponding alterations in the central station plant, to provide metallic circuits, to avoid disturbances to the electrical transmission of speech resulting from the effect of other electrical systems upon single lines with grounded returns.

At a later day even greater outlays have been devoted to the substitution of new types of switchboards, which save to the subscribers the few seconds necessary to turn the crank in calling the central office.

In the face of these lavish investments the economies of the engineer have materially diminished the cost of telephone service, as well as improved its quality.

The economic demand is for time, — the one thing which mankind cannot modify except by immediate transmission of current intelligence, quicker transportation in its reduction of otherwise available time, and artificial illumination in the utilization of unavailable time.

The more extensive introduction of illuminating gas has followed the result of economies by the united effort of engineers and chemists, primarily in the utilization of by-products, and later by fundamental economies in methods of gas generation.

Electrical illumination has been a new art wholly within the province of engineering, and, while its merits were fully appreciated from the first, yet the cost restrained its introduction from reaching a high percentage of development until the tributary expenses were reduced.

In prime movers it extended the development of engine and boiler economies, it has encouraged the return to first principles in the steam turbine, and through its patronage of the impulse water wheel has applied a new art to the utilization of the energy of cascades half a mile in height in the far west, which had hitherto descended unvexed to the lowlands, and has harnessed their power to useful work hundreds of miles distant.

An engineer is fundamentally a constructor and operator, while in an inventor the constructive sense is as apt to be as deficient as his proverbial lack of commercial ability. The

invention of the Bessemer process of making steel was one of the most brilliant productions which ever adorned the results of an inventor; yet it required the work of many engineers to reduce its costs until it could be produced cheaper than wrought iron.

The changed conditions to which the rails of a certain railroad were subjected by the substitution of motors under each car, in place of one locomotive to a train, caused an alarmingly rapid wearing of rails, although of a type of steel which had been used satisfactorily for a long time; under the new conditions of attrition these rails in some places would last only six weeks, but on the advice of an engineer, expert in the subject, rails of a different type of steel were substituted, and the new rails remain in good condition after two years' service.

The analytical method of the design of members in construction by applying the principles of mechanics, combined with the experience of test pieces as constants in the formula, is a characteristic of the economy of engineering in its prevention of unnecessary squandering of material, and, above all, in an avoidance of the hazard of destruction from stresses to which the completed work may be subjected.

Another economy may be the attempt to provide for the inevitable result of depreciation from subsequent invention by avoiding the expense of building for too long endurance, but in the expectation that other means will supplant those of the present, and to be prepared for a limited existence of the work.

At the present time there is a great engineering work under construction in this country, in which the whole design is based upon an estimated endurance of fifty years.

It is a credit and not a disparagement to our civilization that it does not undertake to leave works of outlived purpose, like the pyramids, a wonderment to other civilizations.

In the "One Horse Shay," Dr. Oliver Wendell Holmes, as well as the good deacon, builded better than he knew; for it should not be considered merely as a logical triumph, but as

an ideal of the accuracy of engineering calculations in correctly estimating the strength of each part, and exactly providing for the depreciation of the whole work.

These instances of the work of the engineer as an economist have been cited merely as examples of the method in which the benefits of enlightened civilization are extended to greater numbers.

All of these works reaching to the benefits of many persons are necessarily founded on an extended scale far greater than would be within the means of any individual to establish or his ability to manage, and therefore the great work of to-day is co-operative in both organization and results, the same as has been the case from all time whenever an enterprise was too great for a private individual.

This united effort for an identical purpose is believed to have been customary ever since men engaged on maritime voyages or caravans, when each contributed to the venture and shared in the results.

This theory of its origin is hypothetical, for co-operation among men is prehistoric, — it is based on the belief of man in his fellow beings; and with the advance of civilization the methods of concentrating the resources of many into a unity of action became wisely formulated, for the Romans had the corporation, as we know it to-day, provided for and regulated in their laws.

The successful efforts in the settlement of America were all done by corporations, and the unsuccessful attempts at colonization which were not permanent were those made directly by governments, without the intermediary of local self-government for the control of the settlers.

The greater strength of a number of persons combined for a unity of effort is not a subject for argument, — as an axiom it is old as Æsop's fable of the bundle of sticks; but its beneficial effects upon the individual, whether as a producer or as a consumer, have not been so fully set forth.

The employment of large numbers is a necessity for exten-

sive production, both of which are essential in connection with the needs of dense population, where there are many people to work and to live.

An extensive establishment must be a corporation, because its financing to bridge the gap between payments for the raw material and labor and the receipts for the product is beyond the resources of the individual, not to mention the large amounts to be buried in plant, which requires constant renewal in part.

The association of many people in an industry by its segregation gives better opportunities to the individual, because the subdivision of work in its assignment according to personal qualifications gives to each one more nearly the class of duties for which he is best fitted, and therefore places him in harmony with his environment, and adds to personal efficiency of production both as to skill and celerity more than can be the case with a variety of duties, as under the completion of any course of work by one person.

The shorter time of instruction for subdivided labor reduces the period of tutelage at lower wages to far less time than under the apprenticeship system, whose failures cannot be easily corrected in later life.

The history of those occupying places of responsibility in the service of corporations shows the extent to which the principle of selection and promotion has been used to fill vacancies. There have been no premiums on ignorance, but tools to him who can use them.

While it is properly the custom to refer to labor collectively as being made up of individual units, the same method should be used in regard to capital, which is made up of units whose ownership like that of land may be frequently varying.

The capital in a corporation is an aggregation made up of many units, and, as the shares are almost universally on sale at competitive prices, their purchase is available in amounts suited to the resources of the purchaser ; and to this extent they form industrial savings banks, frequently owned in a material

part by those who also obtain their livelihood from the same source.

While partnerships are rarely available for those employed by a firm, yet a corporation affords opportunities for part ownerships, and proportional share in profits without the imposition of a personal liability, on the one condition of purchase in the open market.

The relationship between the many units forming the sustaining capital and the many units included in the productive labor joined in an enterprise may be likened to a tree, wherein the trunk between these two parts, each essential to the other, may represent the executive head necessary for both.

These positions of headship require persons who can do many things well, because they can do one thing at a time; and, having a sense to quickly reach logical results from information even outside of their personal knowledge, can therefore give generally correct directions and are endowed with executive capacity.

The methods of correct thinking towards results in the direction of just decisions appear to be developed through legal rather than technical training.

Every executive action reflects an equivalent measure of responsibility, and the conservatism which these conditions inspire is shown in the high standard which pervades the conduct of large establishments.

Attention has been called to some of the events of the centuries whose cumulation prepared mankind to receive higher conditions of welfare, also to the efforts which initiated the means of producing improved conditions of life; and, furthermore, to the later types of engineering skill, whose economies have extended these ameliorations to the benefit of larger numbers.

It is evident that the future will be adorned with these betterments as richly as the past; but, beyond the contingencies of the production of new systems of engineering applications, there will still remain extending fields of work in the savings of wastes of time, labor and material.

This type of modern engineering is largely due to technical education, whose results may not be ascribed so much to those of the departments of instruction directly applicable to practice as they have been to the inculcation of scientific principles and logical methods of procedure, thereby training powers of continuous application; and, above all, the spirit of technical institutions imbuing young minds with the inspiration of a definite purpose.

BACCALAUREATE ADDRESS.*

By Henry DuBois Mulford, A.B., A.M.**

> "Then Peter opened his mouth, and said, Of a truth I perceive that God is no respecter of persons: But in every nation he that feareth him, and worketh righteousness, is accepted with him."—(Acts 10: 34, 35.)

Simon Peter, a fisherman of Galilee, stands before the world in so conspicuous a manner that the things recorded of him may justly be held to be worthy of attention. We are under the shadow of his great name, whether we agree with the claims of the Holy Roman Church that he received the Headship of the Christian Church, which those who have succeeded him in the Bishopric of the Eternal City have in unbroken succession held and exercised; whether we quietly or actively dispute those claims made for him and her; or whether we stand apart from the claims and views of all who profess and call themselves Christians. There he stands, anyhow, in history, in literature, in life work, a man of zeal and power, a Rock! It is, I take it, one principle of manhood's mind, one large and proper and noble element for our sphere and progress that we pay true homage of praise and discipleship to all the Great. In Peter, as in Moses, we see that wonderful growth of soul which the Divine Master, Author and Perfecter of the Faith, has taught all men to be the true goal and glory of man's life upon the earth.

Therefore, any such episode as that recorded in our text, pivotal for the man, Simon Peter, beacon-like and soul-stirring for us, please God, is forever notable and valuable: superior even to those great rules and generalizations of the sciences and the liberal arts which so develop the student with their benign and beautiful culture. The Bible affords us to-day, as ever, the most liberal of educations. Above the bookworm and the pedant, the investigator and the expert, is the great soul, the man who eats the Sacred Roll, the man after God's own heart.

Peter was on the threshold of his larger performance and greater worth to his Redeemer and to mankind. He had his three years of special schooling; and now, and yet, he needed a vision. The parallel is plain. We have had schoolings. We need the equipment of a vision for truer living: a vision of God, even according to the burden of Moses' prayer:

> "Now therefore, I pray thee, if I have found grace in thy sight, show me now thy way, that I may know thee, that I may find grace in thy sight: and consider that this nation is thy people......If thy presence go not with me, carry us not up hence!"—(Exod. 33: 13,15)

This text may not belong to that list of most transcendent passages (like St. John 3: 14-16: 1st Timothy 3: 16: Titus 2: 11-14) which contain as the phrase goes, "the Gospel within the Gospel"; but it sets before us a rich and varied message. We have here, in part of course, A Man's Knowledge of God; his Attitude Towards God; his Duty in Life; his Success.

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*Delivered on Baccalaureate Sunday, June 4, 1905.

**Professor of English Language and Literature, Rutgers College, New Brunswick, N. J.

1. A man's knowledge of God. "Of a truth I perceive that God is no respecter of persons." It is true, of course, that all life is a school, and it has passed into a proverb that a teacher named Experience teaches a dear school for a certain large class of learners. But it is also true and delightful that we live in a land and age which abound in institutions providing admirable and varied instruction for the minds of youth. How favored are the young men and women of our States in the provisions made by the State, and by private benevolence for liberal education; and this, not merely that they may be equipped for places of honor and profit, but for a joy, the joy of perceiving! If this be a startling turn of thought to any student who has gone to a school of the liberal or the technical arts, for an equipment and a diploma and a "place", then it should be as welcome as the flash of lightning is welcome to him who is walking in the inky blackness of a stormy night, or as the warning bell buoy to him who is close to the shoals and breakers. What the traveler needs is to perceive, to perceive what he must avoid, and whither his course must be. The Satanic geology, the Satanic mechanics, the Satanic empire-building, did not seduce the Son of God. Turn these stones, these formulae of chemistry and engineering, these tables of the strength of materials, into bread—only this, ye graduates and undergraduates of any sort of the Higher Schools? Nay, for the Son of God resaid to the Adversary what the glorious lawgiver had said to the sons of Jacob, centuries before: "Man shall not live by bread alone, but by every word that proceedeth out of the mouth of God." (Deut. 8:3; Mt. 4:4.)

We are citizens of the Empire State, and no intelligent or worthy child of this commonwealth is content to locate her glories in the list of her millionaires, or even in the totals of the deposits in her savings banks; for our boasts are in the grandeur of Niagara, the loveliness of the valley of the Genesee, the splendor of the sunsets above the Catskills, the entrancing peace of the Adirondack lakes; they are in the marvels of chasm and deposit and growth which bring the scientists to her bosom as pilgrims unto shrines; they are in the deeds of her sons, the light and comfort of her institutions, which make fair her ample page of our country's history. What we need, what we are anxious and proud to have as citizens of a truly great State is a proper equipment of perception. Without it we are not at all as fit as we ought to be to live and to progress through life here. Perception, however, is no merely sensuous thing. It is of the mind; and the cultured mind adds insight to the sight of the eyes. Every science, every art, every course in history and literature, lights up the panorama of our days. It is a joy to perceive the beauty of the laws which bind all things into the "goodly frame" to which the Greeks gave that unimprovable name, the Cosmos. Such perceptions elevate and purify, and yet they do not lead to the heights of perception and of purity.

In "Cleon", one of Robert Browning's finest poems, the necessity of another perception is clearly set forth. "Most progress is most failure," unless man can be brought to see that larger life into which God enters and over which immortality presides. It is God in the Cosmos, God in human affairs, God at the end of human affairs, that crowns man's knowledge and determines his perceptions of this life. Our text gives us one great article in a man's knowledge of God which is very good and necessary for us in our day. This stalwart doctrine,

this bold, democratic creed, is truly a watchword for every young American. For one thing, we remark that our nation must live up to it in the welcome which we give to people from all lands. Indeed, we have been, we are living up to it as no other land has done, and as no other land is capable of doing. Of course. our mention of this vast question of immigration is incidental; we are not called to it by the text. Let others treat of its dangers; we touch in a word its other side. All things should be within reason as to the numbers and the quality of the incoming hosts. One nation cannot, one man cannot do the digestive work of a dozen. But here every man has the best chance for true development which the world affords, the best chance for the best perceptions of life. It is our glory that we provide, not a rich soil and varied industries, but civil and religious liberty. It is our testing in the sight of men and angels that what we provide for all be appropriated and manifested by each. While we welcome those whose desires are unto us for the best place in which to live, we must say and show to them what a republic requires; not a vague, a low idea of personal liberty but a perception of God who is no respecter of persons. You who are here, you whose ancestors have been here for long, must keep this your leaven at work in whatever lump of people you live and work.

For in the second place, we are all very human and we all need this great democratic view of God in our social and civic affairs. We need it if, in the realm of the eighth commandment for example, we condemn the common thief and we are not so ready and so clear in calling a spade a spade in certain large operations of business which yield, if successful, that worshipful thing called a "pile". It is robbery to wreck a business so that it may be reorganized by "freezing out" innocent holders of shares which the freezers want. If, in another line, it be a crime to be a bigamist, and no crime to be repeaters in divorce proceedings; if, in another it be a disgraceful and wicked thing to be a liar, except of course in politics and diplomacy; then, we need this perception. It is one thing, even to a David, to hear a ewe lamb coveted and taken by a ruthless one with power, and another thing when David wanted Bathsheba and ordered that Uriah be so placed in battle that he should be surely slain. It is one thing to worship a carved idol and another to serve Mammon. Ah, the world is full, as it has never been full, of these things which the doers have argued themselves into doing because they are the great of the earth; and the desires of the mighty are, like the judgments of God, true and righteous altogether!

Again, in what is called "society", what respect of persons who are personages, what grasping after the uppermost rooms at feasts, what homage paid to pedigree! What angers at times at our national Capitol if the wife of a Senator or the daughter of a Justice does not get her place in the reception line or at table, to which, most clearly to herself, her position entitles her. In the small towns of any state what social cliques based upon some plebian's fortune, what church cliques based upon the social cliques; and, all these things are done in the green tree and the dry tree, by people who adhere to the religion founded by the Carpenter's Son and spread by a band of preachers mostly Jews and largely fishermen! And Simon Peter, a Jew fisherman hardly out of the business, had had very strong notions that he

could call common and unclean what God had made and cleansed! And in the mercy of a long suffering God he had a vision whereby he truly perceived that God is no respecter of persons, seeing not as man seeth but looking upon the heart. The educated man or woman in democratic America in the twentieth century A. D., needs to know his God in this regard if he would live an honest life towards Him and towards men. To keep from wretched Pharasaic pride, to deal out strict justice and true courtesy to all, is a supreme duty in our land, and a supreme mark of a true American spirit. And in any list of the "hard sayings" of the Scriptures that one, "Render to all their dues," must have a high place.

2. We have in the text a man's Attitude Towards God: "In every nation he that feareth him." It is equally surprising and sad that with the Scriptures before them, Christian preachers have so largely led people astray on the topic of the fear of God. We have had the extreme of Jonathan Edwards, for example, in his famous sermon, "Sinners in the Hands of an Angry God," which sort of thing must have acted upon many a hearer like the maddening lash applied by an ignorant driver to a sensitive horse. And we have the reaction from that extreme to the other, which not only casteth out fear from many a soul that needs to have it, but takes the pith out of the Scripture and out of the Divine Character itself. If, in this passage and many another, the fear of God means a reverential obedience, due to the Creator, Preserver and Judge of his creatures, then it is something as necessary to the kingdom of Heaven as to a citizen of any earthly kingdom. I do not wish to make, or even to suggest any blasphemous comparisons; but I wish to ask, who could have, who did have, any respect for Charles the Second? How easy and complaisant, what a "good fellow" was the "Merry Monarch"; but how immoral, how incapable, how lacking in kingly dignity of character, how ruinous to the nation! Better of the two the arbitrariness, the severity of Cromwell. Best of the three, however, the true fear, not devoid of love by any means, manifested by the English race for Victoria! There is a majesty about God to which no comparison or contrast with moral sovereign is adequate. The starry heavens above and the moral law within, impressed a David and an Immanuel Kant. The thought of personal responsibility to God was the most solemn thought of the great mind of Webster. The fear of the Lord was the beginning of wisdom to Job and Solomon. If any of God's creatures has any inclination to regard Him as the free-and-easy courtiers of the Second Charles regarded him, then, as the proverb says, He resides where "there is no vision and the people passed off restraint."

The late James Parton, who wrote the lives of Franklin, Jefferson, Jackson and others, has left us a sketch of Henry Ward Beecher and Plymouth Church in which he emphasizes the sociability, the human interest, of the preacher and the church life. He speaks of the lack of prominence given to the severer doctrines, and of the joy, not gloom, of religion as marked features on Brooklyn Heights; and then he argues that certain teachings of past generations need not be argued down, they may be trusted to fade out. Perhaps some of them, especially as they have been pushed to extremes, deserve to fade out; but, it must not be forgotten there is such a thing as neglect of truth, a thing which is ever perilous, and which brings, in all realms, from hygiene

to religion, an inexorable loss. The writer of the Epistle of the Hebrews solemnly urges all Christians to give more earnest heed to the things that were heard, less haply we drift away from them. And we insist that this item in a man's attitude towards his God, namely, a proper fear, must never be allowed to fade.

The late Bishop Doane of New Jersey, father of the present Protestant-Episcopal Bishop of Albany, has left us an oration, "The Men to Make a State," which deserves a more prominent place and more frequent use among our classic school declamations for its strong Americanism and pure Christianity. After having said most truly that the men to make a State must be intelligent, honest and brave, he asserts most impressively that they must be religious men:

> "States are from God. States are dependent upon God. States are accountable to God. To leave God out of States is to be atheists. I do not mean that men must cant. I do not mean that men must wear long faces. I do not mean that men must talk of conscience while they steal your spoons....... I speak of men who feel and own a God. I speak of men who feel and own their sins. I speak of men who know there is a Hell. I speak of men who think the cross no shame. I speak of men who have it in their heart as well as on their brow. The men who own no future, the men who trample on the Bible, the men who never pray, are not the men to make a State!"

3. In the third place, not the first, we have in our text a Man's Duty in Life: "in every nation he that worketh righteousness!" In every nation there have been moral codes, and also those who have held high an ideal. In our Republic how lofty those ideals have been! We have had no heathen stage. In the oldest colonies from their earliest days, the Bible, the preacher, the Christian home stood forth, and all adown our history the emphasis has been laid upon character. If America has been another name for opportunity, she has required personal virtue as the price of opportunity's good rewards.

All this is, of course, declamation; it is a generality not glittering with the spangles of novelty; but what else can one do in a few words with the great fields, the arduous fields, of present-day righteousness! The great poet whom we have already quoted looks out upon life thro' the fancied outburst of David's song before Saul, and sees, "All's love yet all's law"; and so the trained student should grasp with one hand all the forces which offer beneficient laws to every life, and with the other he should grasp from the Gospels the great force of love for all the relationships of life. More law in the care of the body, in the health of the city; more reason in the use of time, in the pursuit of business; more fidelities to good causes, more truth in the inward parts; more breadth, more depth to life than pleasuring and greed allows; more listeners to wisdom as she cries aloud at the head of the noisy streets! And along with more life, life must have more love in it; love for work; love for poetry; love of home; love for the homeless and ignorant; love of turning many to righteousness! It is only partially true of the individual that the individual withers. The chance of emerging from the mass in a nation of eighty millions may be small; but modern heroes do not need a background, a clientage of serfs and pigmies. Not prowess but purity; not taking cities but ruling spirits, not raven but redemption, are the requisites for modern heroism.

Against the deeds of the Goddess born (Achilles, Æneas and the rest) shall be placed the deeds of the nameless saints who are healing the world, working righteousness in every nation! In a land like ours the individual does not, dares not wither; he expands, he grows in beauty, joy and heavenly grace if he realizes that none in all the course of time has come into the stadium of life for so joyous a race or into the pastures of God for such health of soul.

4. In the fourth place we have in our text A Man's Success; to be accepted with God. There are few more prevalent and insistent utterances to-day than those which harp upon the theme of success in life, and very many of these utterances are on a pretty low plane. I am not saying that all that is evil which we read in the daily press, or in that specialized magazine entitled "Success", concerning those prosperous and successful persons who have built up a business and who have left great wealth behind them to be a blessing or a snare. I am saying that this is a minor success and a scarce article. It is of the earth, earthy; and it is the sign of the operation, in some cases, of that relentless doctrine of science, the survival of the fittest. And many a man who is condemning the Trust magnates to perdition is full of their very spirit but not quite well enough fixed with brains.

There are other similar successes and principles of success which are far from high. Barnum said that the people liked to be humbugged, and he acted accordingly and died rich. Lord Beaconsfield said that all people like to be flattered, and that when you flatter royalty you must lay it on with a trowel; and, he surely "broke his birth's invidious bar" and "shaped the whispers of a throne."

Some join the Masons and the Maccabees with an eye upon their vote: and some join a church with an eye upon social advancement; and some preach to students the value of practical sagacity and tact, of pleasing the women if you are a doctor, of getting the editor or critic or committee, or Board favorably disposed; of being "solid" with one or several sections of the public. And all these lower aspects of that self-seeking which is called success have been too much emphasized, to the degrading of present-day life.

But there are many nobler and earnest men and women who are engaging in work that is semi or properly professional; that is, where the idea of serving the good of men is more prominent than in some more gainful lines. They, too, covet earnestly success in life, which comes indeed to some more than to others through the efforts of friends and through good impressions made by chance, and through the presence in them of social and sympathetic qualities over and above an excellent or a mediocre man of the principles and literature of the subject. As most of those who strive for riches fail of success, so many of these latter workers fail to take the tide of their affairs at the flood, fail to encounter the powerful friend, to secure the worthy position; and spend their lives in the shallows, not in the strongest currents of life. But, even so, there is a certain comfort, a certain success. The artist, to speak of a class most needy of sympathy and often getting very little, may paint well enough to call forth the praise of friendly laymen and fond relatives; he surely wants that practical success which is denoted by actual sales and further orders; but the real touchstone of success is to have his picture accepted by the Board of Judges in charge of first-class exhibition. They know good work.

Their approval argues success in the material sense although there is no schedule time for the arrival of the argosies. The artist's vision of truth and beauty, and his method, may be at variance with the tastes and maxims of the day; he may, as the poet Woodsworth boasted and complained, have to create the taste by which he is to be enjoyed; but even then, through days of poverty unto an obscure grave, his soul has not flinched; he has succeeded, and he will succeed, world without end, with "those who know".

Much more does the fine workman in the moral and spiritual realm succeed, for he succeeds with God, the perfect Judge, the ample rewarder! But, as the Scripture says, "He that cometh to God must believe that he is, and that He is a Rewarder of them that diligently seek Him." (Heb. 11:6.) We repeat what we said about earthly successes and the seeking of the Gentiles, in order to add that materialism of life flows from materialism of creed. It is not a sufficient argument for living while we live, to say sneeringly of the old Puritans and the older Monks that they longed for Heaven and sang of earth as a desert drear because they made life dismal with their horrid piety; for the fact is that modern thought has made life dismal for very many serious souls who cannot longer believe that they are souls.

"The struggle naught availeth,
The laborer and the wounds are vain."

And so we have the old Stoic as well as the old Epicurean among us! Witness the late Professor Clifford, an early victim of consumption, whom Huxley lamented as "the finest scientific mind born in England for fifty years." Shortly before his death Clifford composed his own epitaph in these words: "I was not, and was conceived; I loved and did a little work; I am not, and am content." And a more frightful witness is that poem by James Thomson, "The City of Dreadful Night," with its assertion there is no God and that suicide is any man's privilege of escape from an hideous world. Surely "Most progress is most failure." It is a relief, a spur, to turn to that great man, Simon Peter, who had a vision of God, and a message about God for mankind, even the preaching of peace by Jesus Christ.

Peace with the Judge! This is our comfortable thought as we close. That inscrutable genius, our Shakespeare, has left us in the person of Hamlet's uncle, a wondrous study of a sinful soul which would dignify the play were Hamlet left out. The King is wrestling with his conscience and trying to pray. He realizes that God is no respecter of persons:

"In the corrupted currents of this world
Offences gilded hand may shove by justice,
And oft 'tis seen the wicked prize itself
Buys out the law; but it is not so above.
There is no shuffling, there the action lies
In his true nature and we ourselves compell'd
Even to the teeth and forehead of our faults
To give evidence."

So, in the bitterness of soul, the King comes to realize that success in life is success with God, and that the loss of His favor is failure. But the Christian, who has heard the full sermon of Simon Peter from which our text is taken, who knows that Christ was ordained of God to be the Judge of quick and dead, who knows that whosoever believ-

eth in Him shall receive remission of sins, knows also that God who is no respecter of persons and has a Father's heart for His child, knows that there is no condemnation to them which art in Christ Jesus, knows that even the steepest and thorniest ways of life are ways to the Great Assize, where his Judge is his pleader in all the causes of his soul, and where he shall have, to crown his peace, another vision of God that all things have worked together for good.

SIXTH ANNUAL COMMENCEMENT.

The public exercises attending the Sixth Annual Commencement began with the Baccalaureate address, in the Chapel Hall, on Sunday, June 4, 1905, at 2:30 o'clock in the afternoon. The address was delivered by Henry DuBois Mulford, A.B., A.M., Professor of English Language and Literature, Rutgers College, New Brunswick, N. J. Professor Mulford graduated from Rutgers College, the New Brunswick Theological Seminary, and the Dutch Reformed Seminary of America. For several years he occupied the pulpit of the James Street Reformed Church, Syracuse, N. Y. He has combined with scholarly habits and training, a wide experience in pulpit and public life, with extensive travel and study abroad; and, frequently addresses college students in the Chapel of his Alma Mater, during the course of the year's work.

The Commencement was held in the Chapel Hall, June 9, 1905, at 10 o'clock in the morning. The address to the members of the graduating classes was delivered by Mr. C. J. H. Woodbury, A.M., Assistant Engineer of the American Telegraph and Telephone Co., Boston, Mass., on the subject of "The Engineer as an Economist." After taking the course in Civil Engineering, at the Massachusetts Institute of Technology, Mr. Woodbury was engaged by several commissions of engineers in tests of water works and pumping engines in a number of cities in eastern Massachusetts. He was afterward employed as draftsman of special machinery of the Lawrence Company, of which he later became superintendent. He then became Engineer for the Associated Factory Mutual Insurance Companies; and, later, Vice President of the Boston Manufacturers Mutual Insurance Co., in which positions his duties were connected with making investigations upon the methods of reducing fire hazards of manufacturing property, the principal ones being the lowering of the electrical fire hazards. In connection with the latter work he prepared the first rules for the installation of electric light apparatus, for which he received, a number of years later, the John Scott medal of the City of Philadelphia,

through the recommendation of the Franklin Institute. He made many investigations upon fire apparatus resulting in improvements of automatic sprinklers, and methods of applying other fire apparatus for the protection of isolated manufacturing property. In connection with this work he formulated the precedents of slow burning mill construction, and prepared formulae applying to these methods. For this work he received the Alsatian Medal of the Societe Industrielle de Mulhouse. In 1894, he entered the service of the American Bell Telephone Co., as Assistant Engineer, which position he now holds. He has also made a number of inventions connected with automatic sprinklers, electrical lighting and ventilation of buildings.

PROGRAM.

Music—March—Waldmere.. .. ..Losey

Invocation.

Music—Minuet—Flower of Chivalry,.. .. ..Sudds

Address:
The Engineer as an Economist,
C. J. H. Woodbury, A.M.,
Boston, Mass.

Music—Selection from "The Sho-gun",.. .. ..Luders.

Conferring of Degrees.

Awarding of Certificates.

Benediction.

Music—March—Clarkson Favorites,.. .. ..Stone

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COMMENCEMENT NOTES.

The final examinations for the year began on Saturday, June 3. In the afternoon of the same day, the senior class in Home Economics gave an elaborate luncheon, which was served in the library of the school, at one o'clock, to the Board of Trustees, the Faculty, and the ladies, with Professor Henry DuBois Mulford as their guest.

The annual meeting of the Board of Trustees was held on Wednesday, June 7. In the evening of the same day, the senior class held its annual reception in Clarkson Hall. The final examinations closed on Thursday, June 8.

DEGREES AND CERTIFICATES.

Degrees Conferred, Certificates Awarded and Subjects of Theses

Presented for Graduation, June 9, 1905.

Degrees.

Bachelors of Science in Civil Engineering.

Clinton Alonzo Curtis,.. .. ..Potsdam, N. Y.
Lloyd Woolsey Greene,.. .. ..Watertown, N. Y.
Joint Thesis: Design of a Gravity System of Water Supply for Potsdam, N. Y.

Chester Enos Hudson,.. .. ..Clayton, N. Y.
Thesis: The Micrographic Structure of Steel and Alloys.

Albert Lawrance Sayer,.. .. ..Ogdensburg, N. Y.
Abram Torrey Van Horne,.. .. ..Springfield Center, N. Y.
Joint Thesis: Discharge of Raquette River at Potsdam, N. Y.

Bachelors of Science in Electrical Engineering.

Harry Barney Claflin,.. .. ..Potsdam, N. Y.
Silas Stanley Stone,.. .. ..Potsdam, N. Y.
Joint Thesis: Experimental Study of a Standard Induction Motor.

Harold Sherman Dunsford,.. .. ..Watertown, N. Y.
Michael Leo Stack,.. .. ..South Otselic, N. Y.
Joint Thesis: Design and Method of Construction of a Two Horse Power Induction Motor.

Bachelor of Science in Home Economics.

Charlotte Dezell Seaver,.. .. ..Potsdam, N. Y.
(B.S., St. Lawrence University, 1882.)
Thesis: The Economics of Electric Cooking.

Certificates.

For Two Year Course in Home Economics.

Addah Louise Barr,.. .. ..Ogdensburg, N. Y.
Thesis: Kitchen Utensils.

Anna Belle Cameron,.. .. ..Chippewa, Wis.
Thesis: The Domestic Science Problem in America.

Edith May Ingalls,.. .. ..Hopkinton, N. Y.
Katharine Barker Johnson,.. .. ..Clayton, N. Y.
Joint Thesis: The History and Development of American Homes.

APPOINTMENTS.

The following appointments have been made by the Board of Trustees, to take effect September 1, 1905, except where otherwise stated:

Carl Michel, A.M., Ph.D., to be Professor of Social Science and Modern Languages, beginning February 6, 1905, vice Frederic William Sanders, A.M., Ph.D., resigned.

Dr. Michel's training and experience have been as follows:

A.B., Gymnasium, Darmstadt, 1879; Ph.D., University of Wurzburg, 1883; Travel France, Switzerland, United States, 1884-5; Student, Ohio Normal University, 1885; Professor of Languages, Ohio Normal University, and Assistant in Mathematics, History, Social Science and Pedagogy, 1885-1900; A.M., (pro merito) Ohio Normal University, 1887; Professor Social Science and Pedagogy, Bluffton College, 1900-02; Private Tutor, Ithaca, N. Y., 1902-3; Professor Ancient Languages, Villa Nova College, Villa Nova, Penna., 1903-5.

Myra Brewster Clarke, A.B., A.M., to be Professor of Home Economics, vice Alvena Pettee, B.S., resigned.

Miss Clarke's training and experience have been as follows:

B. of Ped., University of Washington, Seattle, Washington, 1895; A.B., ibid., 1900; Diploma for Elementary Teaching, Teachers College, Columbia University, 1902; Diploma, Domestic Science, ibid., 1905; A.M., Columbia University, 1905. Licenses held by examination; License No. 1, New York City Schools, 1902; for teaching Domestic Science in Summer Schools, New York City; for teaching Domestic Science in Evening Schools, New York City, 1904. Teaching experience, as follows: County Schools, King county, Washington, Elementary Grades, 1896-97; Seattle, Washington, 4, 5, 6, Grades, 1897-1901; Hampton Institute, Hampton, Va., English, Arithmetic, Nature Study and Bible, 1902-3; New York City Schools, Evening Classes and Summer Schools, Domestic Science, 1904; Church of Epiphany, Sewing School, New York City, Domestic Art, 1903-4.

Homer Munro Derr, A.M., Ph.D., to be Professor of Mathematics and Civil Engineering, vice Charles Edwin Rogers, C.E., resigned.

Dr. Derr's training and experience have been as follows:

A.B., Leland Stanford University, 1898; A.M., Columbia University, 1901; Ph.D., University of Pennsylvania, 1903. Instructor in Mathematics, Palo Alto, Cal., Summer School, 1898; Assistant in Physics, Columbia University, 1899-1901; Instructor in Mining Engineering and Geology, University of Wyoming, 1901-2; John Tyndall Fellow in Physics, University of Pennsylvania, 1902-3; Superintendent of Mines, Santa Margarita Gold Mining Company, Colombia, S. A., 1903-4; Professor of Mathematics and Physics, Epworth University, Oklahoma City, Oklahoma, 1904-5.

Francis Patrick Cummings, to be Tutor in Mathematics, vice Silas Stanley Stone, graduated.

Frank Heath Flint, to be Assistant in Surveying.

Arthur Bender McIntyre, to be Librarian, vice Clinton Alonzo Curtis, graduated.

Mildred Mae Parker, to be Assistant in Home Economics, vice Charlotte Dezell Seaver, B.S., graduated.

CLARKSON SUMMER SCHOOL.

The object of holding this summer session of six weeks, is to offer the facilities of the school and to provide instruction for teachers and advanced and special students, and those who are preparing to pass the grade and State examinations in August; for college students who through failure in any course wish to prepare for September examinations; and for those who are preparing to enter college.

COURSES OF INSTRUCTION.

Automobiles. A course in the construction, care and operation of automobiles and boat engines. The equipment consists of a 20 H.P. Olds Touring Car for road practice, an 18 H.P. Rambler Touring Car Chassis and the model of a Standard Olds Mobile Runabout.

History and Literature. Courses in English and American Literature; Ancient, Medieval and English History.

Languages. Courses offered in ancient and modern languages, for beginners or advanced students and teachers, including Latin, Greek, French, German and Spanish.

Mathematics. Courses offered in advanced Algebra, Solid Geometry and Trigonometry.

Home Science. Courses in Cookery, Sewing, Basketry, and Sloyd; lectures, laboratory work, individual instruction; with special reference to the needs of those preparing to teach Home Science.

Manual Training. Courses in bench work in wood and Venetian ironwork, combined with constructive drawings and making models and ornamental designs.

EXPENSES.

The tuition will be from $5.00 to $8.00 per subject, according to branches and character of work taken. Expenses for laboratory and other materials necessary will be charged at cost, as may be required. All students taking courses in practical work will be charged for injury to apparatus and for breakages.

Boarding. Excellent boarding arrangements may be made, at reasonable rates, as given in this Bulletin, under the item of expenses for attending the Clarkson School of Technology.

Circulars containing full information of each of the courses announced will be sent upon application to

The Secretary,
Clarkson Summer School,
Potsdam, N. Y.

July 5, Wednesday.......................... Registration
July 6, Thursday..................... Instruction begins
August 16, Wednesday.................. Instruction ends

WEATHER REPORT.

REPORT TO JULY 1, 1905. Observations made at Clarkson School of Technology, Potsdam, N. Y.	AVERAGE. Temperature. MAX.	MIN.	MEAN.	Barom inches.	TOTALS. Precip. inches.	Snow inches.
Month ending Jan. 31, 1905	19.8	1.4	10.6	29.25	2.30	25.0
" " Feb. 28,	21.5	-1.4	11.0	29.72	1.98	17.5
" " Mar. 31,	38.2	15.7	26.8	29.15	2.45	8.0
Week ending April 1, 1905	53.6	33.7	43.6	29.66	0.30	
" " " 8,	50.0	29.7	39.8	29.44	0.88	6.0
" " " 15,	53.5	31.8	42.7	29.35	0.80	
" " " 22,	47.5	28.5	39.8	29.55	0.80	9.0
" " " 29,	63.3	37.0	48.7	29.47	0.06	
" " May 6,	60.0	41.0	50.0	29.63	0.75	
" " " 13,	68.1	44.0	58.2	29.58	0.70	
" " " 20,	65.6	49.7	57.6	29.39	1.16	
" " " 27,	67.3	44.0	56.0	29.63	0.58	
" " June 3,	69.8	42.8	55.6	29.64	0.82	
" " " 10,	68.3	47.0	59.7	29.58	1.45	
" " " 17,	78.1	60.7	69.4	29.53	1.67	
" " " 24,	82.5	60.5	71.5	29.62	0.85	
Month ending Apr. 30,	53.0	31.6	43.0	29.43	2.76	15.0
" " May 31,	66.1	44.7	65.5	29.57	3.32	
" " Jun. 30,	75.5	53.4	64.7	29.59	5.57	

The precipitation includes all rain fall and snow melted.

Thomas S. Clarkson

Memorial

School of Technology

Potsdam, N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language and literature, the applied and economic sciences, engineering and technology. They lead to the degree of Bachelor of Science in the major course pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical and mechanical engineering. The instruction taken in common during the first two years provides the elements of a liberal ednCation. Based upon similar instruction in the fundamental principles of engineering science, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting tests and researches.

The technical instruction of the last two years, in the theory and practice of engineering, affords the student substantial preparation for immediate usefulness in engineering workshop or laboratory, office or field, by intelligent application of principles to the successful mastery of his field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their chosen profession.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

Clarkson Bulletin

Vol. II October, 1905. No. 4.

Thomas S. Clarkson

memorial

School of Technology

Potsdam, N. Y.

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Announcement: The Clarkson Bulletin is published quarterly It will be mailed upon application to

The Director,
Clarkson School of Technology,
Potsdam, N. Y.

ON THE STUDY OF ECONOMICS IN THE CLARKSON SCHOOL OF TECHNOLOGY.

By Wm. S. Aldrich, M.E.*

The place of Economics in the curriculum of the engineering courses of this Institution may be seen by its position in the order of required and elective studies for the baccalaureate degree. It is taken up in the second semester of the sophomore year, and is followed, in the junior year, by courses in the economics of industry and of manufactures; and, in the senior year, by a study of the laws of operations preliminary to construction in engineering and of contracts, specifications and the economics of the development and execution of engineering projects, and the ethics of engineering employment and professional practice. It will thus be seen that there are two and one-half years, or five semesters of instruction in subjects directly or indirectly related to Economics in its bearing upon the profession of the engineer. Moreover, these courses are required in common of all students, candidates for the degree in engineering.

The study of Economics as at first treated includes a survey of the principles and outlines of economic theory. Consideration is given to the laws which it has been attempted to formulate, either to account for man's eristing economic relations or to forecast their possible future development. This involves a brief survey of economic history with a comparative study of its present tendencies. It touches upon man's economic evolution and responsibility, his rights, privileges, and duties; the growth of industries and the course of trade and commerce; the question of capital and wages, the relations of employer and employee, as seen in the rise of the labour movement and the combination of capital; the ethical, economic and social gains that have come through legislation; and state management, regulation and control. Reference is primarily made for illustration of economic laws and principles, to the application of these in modern business, manufactures, engineering construction and works, and power development.

This course is followed, in the first semester of the junior year, by an economic study of the natural resources and of the machinery, transportation and industrial organization necessary to their utilization. In short, materials, methods and men now engage the attention of the student. The relation which the engineer bears to industrial efficiency is steadily kept in view throughout the first application of the principles of economics to this class of engineering enterprises. A study is made of the occurrence and statistics regarding natural resources; the influence of materials upon national power, social progress and industrial development; the evolution of man as a tool-using animal; the influence of inventions and patents on industrial progress; the engineer's relation to tools and materials, and to the men who own them and who use them; the economics of production, costs of materials, labor, maintenance, rent, interest, taxes, insurance, depreciation, repairs, renewals, profit and loss; disposition of waste or bye-products; standards of values in estimating services rendered and

*Director, Thomas S. Clarkson Memorial School of Technology.

processes and work of production; prevention of accidents; employer's liability and risks; industrial competition and efficiency.

Following this course in the economics of industry there is given, during the second semester of the junior year, a course in the economics of manufacture. This includes a study of modern methods of workshop production, from the design to the finished product. Attention is also given to the influences of standardization, duplication and interchangeability of the machine elements which may constitute any proposed line of manufacture. Shop orders and shop accounting systems are discussed, with their relations to material and labor, and the several departments in an efficient organization for economic production in manufacturing industries.

In the senior year the course of economic studies is continued, with discussion of legal and customary regulations bearing especially upon engineering construction and professional practice. At first a survey is made of the law of operations preliminary to construction in engineering, with a discussion of the rights and privileges incident to the ownership of real property, water supplies, water powers and power developments, boundaries, rights of way for canals, railways, transmission lines, etc. Following this is a course in the laws of construction as related to contracts, bids and bidders; the employment of engineers and the ethics of engineering professional practice; specifications, estimates, appraisal; the course culminating in the closing quarter of the senior year in an economic study of some engineering project, with accompanying designs, tracings, blue prints, specifications, bills of materials, estimates and plan of organization for its development and execution.

Non-mathematical, yet not non-scientific, these economic studies in a school of technology serve to weld those interests which tend to become more and more divergent as the day of graduation draws on. Moreover, they are a wholesome check upon the excessive narrowness of view frequently arising among otherwise well-meaning technical students. These limited horizons naturally result from the pleasurable pursuit of a specialty, opportunity for which the school affords students as they become better prepared to make intelligent use of its facilities for scientific work and research, and so to gratify their ambitions in this respect.

During the first two years of instruction, therefore, the principles which underlie the applied and economic sciences, engineering and technology, are developed and illustrated as foundation courses. At the end of this period the student chooses the group-electives, in chemical, civil, electrical or mechanical engineering. The aim of the subsequent instruction is, as formerly, to develop habits of clear, accurate and logical processes of thought and work. This remains true, however specialized the instruction of the last two years may become, in its relation to the theory and practice of engineering. It is alone by preserving such a balance as a kind of equilibrium, amid the conflict of studies and the clash of individual preferences, that the technical training may afford the student substantial preparation for at least some grade of immediate usefulness in engineering workshop, laboratory, office or field.

In presenting such a program, so much of it as is fundamental and essential to any consideration of the subject must remain. The rest will pass with the years, constituting, as it does, that variable

element to be noted in the growth of every kind of human knowledge, without whose passing and replacement there could be no progress. In other words, the passing and permanent, whose delimitation constantly baffles the ablest minds in every branch of science, are singularly interwoven in the complex patterns formed by the warp and woof of modern economic society.

Tactical arrangements of a fleet in action have been made which were better suited to other days and seas, with primitive motive-power, such as oars or sails; and which have, therefore, proved a strategic blunder. Engineering industries offer many a parallel, with their antiquated arrangement of plant and machinery, and old-fashioned notions of the management of men, in open and direct competition with an establishment continuously adapting itself to the new conditions fast coming on in every generation. These latter have the mobility of a living organism. The method of conducting the business which brought success to one generation, under one management, brings failure to the next. Men may come and go; materials, methods and processes may, indeed must, change with the years; but the life of the establishment as an institution goes on. It gets the business from the public to whose demands it caters while it ever seeks to create new demands for its growing industry and expanding trade.

A prominent manufacturer was asked why he did not arrange his new establishment upon at least the same general lines of development as the old, with which he had achieved the success which made possible the new. "It cannot be done that way again. We have found that the movement of materials and labour, from one end to the other of a shop, in a straight line, is no longer economic, under the new conditions of power transmission and the possibilities of the industrial railway within the works, all operated by electricity."

Intensified production in modern manufacturing work requires the destructive use of machines and tools, and some engineers of the old school, think, a destructive use of men. It is possible judiciously to expend power, materials, tools, and, we may add, men, and yet increase in efficiency and capacity for the performance of a given function in productive work. The organization of modern industry demands an efficient management of men for maximum output, as well as an economic use of material for minimum waste. On the other hand, to withhold more than is meet, more than the most rigorous application of the principles of economics would dictate as expedient, will tend to waste of power, poverty of materials, inefficiency of tools and of men, with only one goal and that the closed business or establishment.

The throwing of costly manufacturing machinery into the scrap heap, like the discarding of an incandescent electric lamp before it reaches its "smashing point," is but another instance of where an apparent loss results in an economic gain. It seems contrary to all economic laws and precedent to conduct a business or to use any appliance on this principle. Nevertheless, this process of elimination of the inefficient, not necessarily of the outworn, nor of the unfit, has vindicated itself by its results.

Applied economics, therefore, is no exception to the other branches of applied science useful in the business of engineering and the technology of its methods and processes of production. It requires the constant exercise of good judgment and reason, in fact, of sound

common sense, as in every other form of human activity. The railroads of the country, for instance, cannot at present be developed and operated upon the principles of the earlier stage lines, whose routes their branches not infrequently parallel. Even the economic theory of the location of steam railroads finds its once tentative but now reasonably established principles subject to change without notice, in the more recent development of interurban and heavy electric railroading. Much forecasting of the probabilities of wind and weather and the influence of ocean currents, all affecting more or less the cargo and delivery risks taken by the old-time skippers, independently, or in trading for some commercial house, the XXth century shipper has not to take anxious thought of, with his steel freighters and turbine steamers, and wireless communication with ships or ports, from anywhere on the high seas.

Many of the worst evils of the sweating system and of child labor still exist in our midst, because it is not recognized that it is impossible to conduct the one or to employ the other, as in cottage industries of the century before the last. From the dinner pail and cold coffee, for all operatives, to the factory lunch counter and dining and rest rooms, is a step, but it is a momentous one. The modern industrial organization, with its army of employees running into the thousands is not exempt from Napoleon's dictum. Efficiency is a question of food and sanitation, in either case. The care which the Japanese army and navy took of the men is likely to be turned to account in the impending evolution of Japanese industries. "A man's a man;" and he is worth caring for in factory and field, on shore and afloat, if for no other reason than that it pays. As it is understood to-day, this is a practical, working hypothesis, a serviceable reason, promising better things. As man ascends the economic scale higher motives will displace it if they are not already operative.

One of the contributions of the XIXth century to economic evolution is that which has served, at least, to show man's relation to materials and the material resources and the forces of nature. In this respect he has now secured some small portion of that dominion over them once vouchsafed him. He has wrested from his physical environments greater degree of comfort, and greater aids to his advancing civilization than ever before in the history of the race. It may be that a similar contribution of the XXth century will show more clearly than has been seen the fact of man's economic dependence upon man; and, the principles which follow from such a recognition, of man's economic relations to man. In other words, the ethics of industry demand a share of attention. It arises from the growing sense of human brotherhood, of mutual responsibility as well as of individual accountability. For the present, the lowest of reasons prevail for recognizing such responsibility, in that it pays. It guarantees largest returns and dividends from extreme subdivision of labor. It ensures most efficient application of skill and of ability, from extreme specialization of production. Nevertheless, the man behind the tool, the machine, the business methods, the productive processes now obtains a hearing. Such ethics as are coming to pervade industry are founded upon another law than that of expediency and profits, or whether it pays. It is the law without which the tool-owner may not expect to secure that benefit which is due to him as employer and master, nor the tool-user that betterment of his condition in life to

which he is entitled as employee and man. In other words, we seem at least to have entered upon a stage of economic development which is to be pervaded by the spirit of altruism. The influence of such motives is now well recognized in many industries. It is destined to be taken account of by all, if they are not to perish as failing to respond, in their organization and management, to the new laws operative in the social fabric, requiring a decent respect for the welfare, conditions and opinions of the world's workers.

This power of continuous adjustment to an ever-changing environment means continued existence as any industrial enterprise, and continued success to its business. It is in man's economic relations as in his physical, so well expressed by Spencer: "Were there no changes in the environment but such as the organism had adapted changes to meet, and were it never to fail in the efficiency with which it met them, there would be eternal existence and eternal knowledge."

Power and capacity for continuous adaptation with unfailing efficiency in the performance of function under the new conditions, makes possible a type of economic freedom, for master as well as man, for employer and employee, for tool-owner and tool-user. Applied at once to the larger sphere of engineering industries, it must inure to their perpetuity.

What a study of tactics is to the student of military science, the study of economics is to the student of engineering science. The one bears that relation to the success or defeat of strategy that the other does to the achievement or failure of an engineering forecast for business enterprises. The engineer occupies much the same relation to the captain of industry, with his board of directors, that the field-marshall holds to the commander-in-chief, with his strategy board. There are times and seasons when, in the midst of some pressing exigency, each man must act upon his own initiative, upon the strength of such information as perhaps he has gathered only the last minute; and, take the consequences.

For safe and rational conduct under the storm and stress of circumstances incident to his vocation, the graduate engineer should have early formed for himself a reasonably satisfactory working hypothesis or philosophy of life. This is now expected of him as a modern type of minute man, as a man of action and of affairs. He is to be as capable of at once assuming command in an emergency as of rendering faithful service in performing routine tasks. The provisional charting of his course, therefore, should be based upon certain well-defined and fixed principles combined with a recognition of established laws and accepted historic precedent, in order to determine his point of departure. From the aim and scope of this course of studies and of its relation to the curriculum of a school of technology these essentials are to be sought for in the domain of economics and of ethics.

The attitude to life and work of an engineer, therefore, concerns itself largely with his economic relations to materials and his ethical relations to men. After such a course of study the conclusions which he may reach are to be most thoroughly sifted. Many of them are to be held in abeyance, in solution, as it were. Some of them are to be rejected. The judgments submitted to him for approval should be carefully scrutinized. Not a few of them are to be held in suspense. All professional ideals must be clarified. If neces-

sary, these must be subjected to constant and repeated reference to some economic basis, some ethical datum.

The graduate who essays to deal with materials and labour as he finds them in the open market, with no respect for the economic teachings of history, however little the philosophy of its movements may yet be understood, and, moreover, with no consideration of current tendencies in the evolution of economic man, is foredoomed to failure in the larger life work of the engineer. He may succeed in other professions but not in that of engineering. This is a profession whose prime purpose is the economic development and utilization of the forces and resources of nature for the comfort and convenience of man and to promote his continuous advance in civilization, which now requires, in the present environment and at this stage of his evolution, to be guaranteed by a reasonable satisfaction of his material needs. The possession of an economic sense, of a true and just appreciation of values, whether of power or of resources, of time or materials, of money or labour, accompanied by an ethical sense of proportion regarding the things which are true and just, as to his rights and immunities, duties and privileges, or any of the exacting inter-relations of these to his life and work, furnishes at least one criterion by which the paying public may judge of the propriety of the title of engineer for the graduate of any school of technology, whatever degrees or other academic honors may have been conferred upon him.

In the economic studies above outlined, the engineering student may lay at least one course of a broad foundation for the superstructure of his professional practice. It will provide him solid ground to stand upon. It will be to him and serve the purpose of a philosophy. This is the light in which he will come to regard and to understand the phenomena attending the economic use of materials and the ethical treatment of men, in further securing dominion over the forces and resources of nature. The chief function of the engineer in such an achievement is in the handling of these two elements, material and labor, as principal factors of production and construction. He may go farther than this as engineer and scientist; indeed, it is his duty to his profession and to mankind to do so. He may, by way of induction, conceive of new and tenable hypotheses, based upon scientific generalizations. When thoroughly tested and tried, and found not lacking in any prerequisite, these may come to be accepted as of sufficient value and precedent as to warrant formulating into new principles and establishing new laws. Contributing thus to economic movements of thought and striving to raise the ethical standards of work, the engineer, as man, will come at last consciously unto his own.

In advance of such a realization will come a feeling of unrest, a kind of disquietude as to his place in the work-a-day world. He had looked for a different heritage from this. In the highways and byways of the great engineering establishments and corporations he loses himself only to find himself, quite likely, one of the multitude that keeps tread to the marching orders of some captain of industry. In the midst of such personal competition, which to him at the same time is the best professional training and experience, he develops intensity of application, self-reliance and earnestness. There is a new and ever renewable joy in work. The barriers thrown across his

path furnish but so many more incentives for him to wrest success from most exacting economic conditions which have spelled failure for less clear heads, and hands not so steady and willing.

Influences and untoward circumstances are at work, as in other vocations, tending to benumb the engineer's sense of the intrinsic value of man. They gather about him and hedge him in on every side. They seem of themselves to close in upon him as the walls of some contracting prison cell. But, with growth in knowledge and in application, direction and execution, there arises a keen sense of sympathy for the economic struggles of other men, and a lively appreciation of their work and worth. When he awakens, as an engineer, therefore, to the consciousness of his power over men and materials, as well as over himself, these baleful influences fall away and disappear. No such middle wall of partition is now seen to exist, separating his welfare from that of the common lot.

Thenceforth, he no longer considers himself and fellowmen apart from economic relations to environment, and ethical relations to each other. The primitive economic sense of dependence and of mutual human interdependence now returns unto him, notwithstanding his developing individuality, and just feeling of personal independence. It is the same point of contact, the same ineffable touch, which, earlier in his own life, enabled him to share the joys and sorrows of comradeship. As it begins to dawn, the engineer perceives and inquires what part he will have in the advent of ages long foretold, the new era, the new epoch, when man shall awaken and stand upon this earth; and, when, in working out his destiny in the growing light of that Wisdom, which vouchsafed to him dominion, he shall forward press, with unabated breath, unto fulness of stature of perfect man with ever tendency to God.

THE ENGINEER IN MANUFACTURING INDUSTRIES.

By Walter S. Graffam, B.S.*

Before explaining the position which the engineer holds in relation to manufacturing, whether he be engaged in the civil, mechanical, electrical, mining or chemical branches (in many instances the professional work overlapping to such an extent that it would be difficult to discriminate),it will be necessary to state what is meant by manufacturing industries.

In a broad sense, a manufacturing industry is one in which something is made or produced. Ordinarily, when we speak of these industries, we do not have in mind the manufacture or construction of steel bridges, battleships, locomotives, etc., but rather of smaller articles, such as machine tools and special machines, small and delicate apparatus, instruments of precision, articles of clothing (boots, shoes, etc.), food products, jewelry, typewriters, bicycles, automobiles, and other products of the shop, the mill, and the factory. It is this second class to which we have reference, although much of what is here discussed will apply equally well to both classes of industries.

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*Superintendent of Shops, Thomas S. Clarkson Memorial School of Technology.

The opportunities opening up to young engineers to-day are more numerous and varied than ever before. We find them entering almost every walk in life, from that of day laborer to that of general manager of works under large corporations. Why should there be noticeable such a range of vocation? It would seem that it is a natural consequence of the training which the engineer must undergo. This education is now reckoned among the broadest and soundest that can be had in the time usually allotted to preparation for one's life work. In speaking of the engineer in this connection we refer to one who has been liberally educated and technically trained, in a thoroughgoing course of engineering instruction, of at least four years duration.

Before manufactures are established, it is necessary to settle upon something to manufacture. This implies that the inventor must have been previously in evidence along that line of industrial development. The inventor is not made for the occasion, but the occasion makes the inventor. By which we mean that very few inventions of real and permanent value are ever made by persons saying to themselves,—"I guess I'll get up an invention;" and, thence setting to work to do so. An invention is almost always the direct result of some urgent need. John Doe, let us say, has a definite operation to perform on an article which he is making, which necessity impels him to invent the appliance or machine with which to execute it. Or, he sees at once the need of utilizing waste or bye-products, whereupon he endeavors to devise a machine or a process in order to put these into marketable condition. Inventions thus spring into existence from necessity; a few are good, and worth financial backing and technical development; the many are really good for nothing.

There are new problems, on the other hand, arising in manufacturing establishments almost all the time. It requires inventive power and ability to solve them. The one man to whom all others look in this direction is generally the engineer. He has had the training which fits him to undertake such work. He is familiar primarily with mechanisms and the nature of mechanical movements. He has a knowledge of processes, methods, forces, and the natural sciences, including chemistry and physics, electricity and magnetism, hydraulics, etc. He may bring to his aid all of these agencies in solving such problems. He understands, moreover, the nature of materials, their elasticity and resistance. An inventor need not necessarily have graduated from some engineering school. If he has been thus educated the chances of his success are greatly enhanced. His work will be more thorough because more complete and scientific. It will be more satisfactory, perhaps, also, more simple and reliable. He will not be likely to spend half his life in following up some phantom, as perpetual motion, for instance.

It may appear that we have been using the term inventor as synonymous with designer. It is not so intended. The designer works up the inventor's idea and carries it through the next stage of development necessary for workshop production. He puts it into tangible shape so that it will be of value to the world. We have reference to two classes of designers,—those who are employed in designing machinery, tools, appliances, etc.; and, others who may be classed as artists, being engaged in designing textiles and textile fabrics and patterns, wall paper, jewelry, etc. The latter will not come under the present discussion. They are usually educated in special

schools of design and industrial art. Their productions are more related to the art side of industry than to manufacturing.

The mechanical designer, as he may be called, is to be found in nearly all manufacturing establishments. In most instances he will be a graduate of some reputable engineering school. He will be trained to grapple with the new and difficult problems incident to building up manufacturing industries. He will know how to go to work, and to set about solving a problem in a rational and logical manner. He will be quick to discern where the fundamental principles may be applied, and recognise that it is with these that he must begin. In time he will have acquired power to master each successive step; otherwise, he cannot arrive at any reasonable conclusion of the problems presented, which shall be at once satisfactory to inventor and designer. Similar preparatory work he has had to do under instruction, in his engineering course, and it now comes into play.

Probably more than fifty per cent. of the chief draftsmen in our large manufacturing works are graduate engineers. They have come to occupy excellent positions of trust and responsibility, at good salaries. In several instances they have men under them for the final success of whose work in relation to their employer's interest they must, as inspector and supervisor, take the praise or blame, as the case may be. Mistakes made in their department not only affect themselves, as well as the employees who make them, but very materially concern the other departments of the establishment. A wrong dimension on a drawing, if allowed to pass, may cause the loss of hundreds of dollars to the firm, through having to throw out, in consequence, some large casting, for example, and, causing delay in machines and processes which may mean forfeit money required to be paid for every day's delay in fulfillment of the contract. The position of chief draftsman, therefore, is one which requires considerable executive ability and ceaseless vigilance.

Similar exacting requirements hold for the position of overseer or department foreman. His place is second only to that of superintendent. Here again we find many graduate engineers, managing and carrying on successfully the work of their respective departments, any one of which, in several manufacturing industries, is a good sized establishment in itself. It is here that the engineer must have many of the qualities which go to make up the successful superintendent, general manager or president of the company. He must himself know how things should be done. Otherwise, he cannot properly instruct his men with regard to getting out work, or the amount of time and material any given order should consume. He must have and continually exercise good judgment; and, be able to make close estimates of cost of work. It is he to whom the superintendent goes for information when planning and starting some new project. Furthermore, such an overseer must be able to live up to his estimates, and to see that the work is executed within schedule time and estimated costs.

Above chief draftsman and head foreman, in the organization for manufacturing, are men with years of experience as engineers, an increasing number of whom are technical graduates, filling positions of superintendent and general manager. These are the places of the greatest responsibility. They are or ought to be sought after by every

engineer of ambition and ability who desires to make a success of the manufacturing work with which he may be connected.

It seems self-evident that the educated man, the trained engineer, should be the one best fitted for these and similar positions of great importance to the advancement of our manufacturing industries. The engineer has done and is doing, for the advancement of civilization, all that enlightened man may do within the province of his chosen field of work. He is becoming responsible for the welfare, safety and security of human life, as well as its betterment under the conditions of modern society; and, to a far greater extent than many other professional men. As such he is a factor to be reckoned with in the present and future development of our national power. Why are such men, it may be asked, better fitted to occupy executive positions in manufacturing industries than those who have been otherwise trained? Examining the statistics of but one institution of learning, we find that about forty per cent. of its graduates are in executive and administrative lines of work. The managers of public works, it may be noted, as of electric lighting, street railways, water and gas works, etc., are coming to be the picked men from among the successful graduates of engineering schools, as has also been noted in reference to the larger manufacturing industries.

The man in an executive position must have a broad training. He should be able to manage men and money, to discuss matters intelligently which are outside of his special sphere of work; and, to meet those with whom he comes in contact (whose capital he has to handle), upon their own level, intellectually and socially, so that the influence exerted may be mutually uplifting, of benefit to master and man, to employer and employee. Evidence of professional ability and skill, together with breadth of culture, will create increased confidence in the judgment of such men, and in the conclusions reached and advice given in any case. Capacity for the correct presentation of ideas and projects, in the most skillful manner and fitting language, is also of the utmost importance. This requirement the graduate engineer should be able to fill, for his education and training in the representative technical schools have been such as to permit of nothing lax in this respect. In all of his courses of instruction, of reading and mathematical studies, of laboratory experiments, computations and designs, he has been thoroughly drilled in details and the accuracy of work.

Throughout his educational career, the engineering student is habitually confronted with the necessity of ascertaining the efficiency of operations, of processes and methods; that is, the value of the relations of cause and effect in the development of some work. He finds that efficiency is, in a sense, the measure of the value of the relation between these, the ratio of work put in to work given out. This is not only a vital point in the theory and practice of engineering, but holds equally true as a measure of the value of man's relation to his work, in all phases of business.

In another sense, the efficiency of a manufacturing industry is the relation of its income to its outgo, or expense account. Such industrial efficiency, however, is made up of the efficiencies of all the departments. If one department of the establishment is affected and allowed to fall below the normal, it tends to reduce the efficiency of the whole. The man who can best analyze the situation, in any

given instance, and determine the cause or causes of success or failure, as measured by high or low industrial efficiency, is, in all probability, the one who can apply to the solution of the problem his own training and experience.

Among the first things which the engineering student comes up against, so to speak, are thoroughness of work and completeness of records. In an institution as in a manufacturing establishment, tab must be kept on the operation and efficiency of men and of machinery, sometimes at frequent intervals. Wastes must be prevented and forethought exercised to do this. The conditions are similar to those which must be met by the manager of a successful business enterprise. They are exacted of him. If his early training has been such as to aid him, in this respect, he is to that extent so much better equipped than his competitor.

One of the most familiar diagrams to the engineer is that of a curve, plotted on squared paper, to show the relation between two variable quantities. Through its constant use and numerous applications we become conversant with its power of analysis, oftentimes enabling us to determine the law between the quantities so plotted, and thence to anticipate results in the performance of machinery. There is no reason why the same method may not be applied to the data of an industrial establishment and with as much value to the user. The manager or superintendent should know for each day, week, or month, the exact details of each department under him, and have these records available for future reference. The readiest way will be to plot a curve of such data from day to day, for a week or for a month. A series of such curves carefully drawn will enable him to determine certainly and at a glance, the situation for each day, the amount of progress made on any given piece of work, and the cost of the same, as well as the daily expense account.

When the engineer wishes to ascertain what the cost will be of a certain project, what his machines and men are capable of doing in the line of work proposed, he resorts to a set of thorough tests, such as will supply the needed information upon which to base the future work. In this respect he is quite likely to have the advantage over his competitor in knowing, from the result of his tests, precisely what it is the next best thing to do, what further investigations are required to be made, and when and in what direction. How many business men to-day, who have not had an engineering education, would listen to one who should thus ascertain and inform the manager of his works that the furnaces were consuming twice as much coal as need be, and further suggest that continued records, under known running conditions, would show just where the coal bill might be reduced?

In another instance the manager walks through the establishment, inspecting the progress of the work and noting the operation of the machines. "They are cutting," it is true, he will hear. But, are they cutting all that they should under the circumstances? If not, why? Does the foreman permit the waste of time and power? If so, why? If the foreman does not know, or does not care, it is time to change to a new foreman in that concern.

From the day the student enters the institution to the day when he takes his degree certified by a diploma, he has been obliged to keep note-books. The value of these will vary in direct proportion to the style and manner in which they have been kept as well as in their accuracy. If properly arranged and indexed he will find many use-

ful items in them for future reference. These may save him, later, hours of valuable time and laborious search for information. They may perhaps save him many dollars. In one respect, at least, he has learned how to collect and preserve data and information upon which he may rely. It is some such work as this which must be done by the executive in any large establishment, only to a much greater extent. The manager's note-book covers a different field, perhaps assumes various forms, as card indexes, scrap books, filing cases, sketches and drawings. If any one or all of these are kept in the way in which he should have learned to keep his engineering records, they will certainly save him much time, worry and anxiety at some critical moment.

One of the most important features attending the industrial development to-day is the free interchange of information. In this the engineer may well take pride, for he is pre-eminently the leader in such professional co-operation. The various technical and engineering societies have proved themselves of incalculable value to the business interests of the country. In their meetings there are freely discussed, even between the representatives of competing companies, the causes which make for gain or loss in works management, the most satisfactory methods of performing operations, and the best principles and theories upon which to conduct the business. In fact, papers and discussions are now presented before these societies eliciting and developing many points which a few years ago each establishment would have guarded with jealous care, as a part of its own particular business and which was not its concern to make known to the public. The time has come to recognize that it is of mutual advantage to all parties interested, the manufacturer as well as the purchaser, to exchange ideas and opinions, records and methods. Even between neighboring firms and competitive producers of the same commodity, we find such interchange of views and discussion welcomed. They lead to better ways of taking care of the troublesome details with which each concern knows the other is hampered.

The engineer who has had the education and experience of which we have spoken, knows where to place apparatus, tools and the machinery for the generation and transmission of power. In general, all of his equipment will be so located as to be most serviceable and efficient. The same training in ability and capacity enables him to place likewise his men to the best advantage. Throughout the works, as planned, materials and labor will then move along with the least amount of friction and delay.

The men whom the executive engineer manages are working as co-operating, and yet in a sense as competing units. The process of shifting men, nevertheless, continually goes on. It is oftentimes made without reason in the opinion of those who are not given larger opportunities or larger pay. The works manager, however, is always frank and courteous. The employees over whom he is in temporary control are men like himself. Their mutual interest is aroused as the work progresses and some measure of its efficiency begins to be apparent to their credit. In such management, when it is most successful, there is always exercised sound common sense. If his men do not stand the test nor increase the efficiency of their machines and work as well as the efficiency of themselves, the manager must needs secure those who will. This it is his duty to do, in order to add to

the success of the company, and the worth and advancement of its undertakings. In the long run, these essentials are not to be considered as separate and distinct from the welfare and interests of the men who make the establishment.

The manufacturing industries are every day opening up larger opportunities and more responsible positions for the trained and competent engineer. His work is sensibly appreciated and felt, as time moves on, to be more and more in closest relation to the public good. It is a very serious question whether, without the engineer, we should now be enjoying the conveniences of travel and transportation, the transmission of intelligence, healthful homes with agreeable surroundings and public sanitary conditions, as well as the material prosperity that follows the development of our natural resources. To-day, we find the engineer in almost all of the various types of industrial establishments, wherever, in fact, raw material is to be manufactured into a finished and marketable product, as in the textile and other industries for the manufacture of cloth, fabrics and articles of wearing apparel; and in the manufacture of food stuffs and provisions. He is steadily at work developing the timber and mineral resources of the country, improving its rivers, harbors and irrigation. He is building up the material structure of the modern city, its parks and boulevards, its water supplies and drainage, its lighting, transportation and fire protection systems. Through the refinement of the instruments of precision which he has made, he has brought the stellar universe within reasonable distance for mapping its systems and investigating its elements, enabling man to arrive at a truer and nobler conception of his own place in that universe.

Many are saying, as of the older professions, that that of engineering is becoming crowded, notwithstanding the fact that every day witnesses an enlarging field for its work. New materials, processes and methods demand new men. There is scarcely an article of useful manufacture which does not have its origin and development in such relation to the engineer's work that without him it would not have been or it would cease to be. He is ever moulding and shaping things to useful purposes. In view of this fact it does not seem plausible to say that the young men of to-day will not find the opportunities awaiting them which the past generation enjoyed. They may not find the same opportunities; but, it is the privilege of the engineer to make opportunities. The supply of educated and trained engineers, of competent thinking men, capable of forming the strong advance guard of the profession, is not yet, nor is it ever likely to be equal to the demand. Those who enter this field with the determination to succeed, cannot be disappointed unless that determination is allowed to sag.

"The almost invariable consequences of engineering training,—thoroughness, command of details, observation and the comparing of observations, appreciation of the value of continuous records, courage and ability to grapple with new conditions, faculty of organization, the concept of the fundamental importance of efficiency,—these are more and more demanded of the manager of the great undertakings which characterize modern material civilization."

HOME ECONOMICS IN ITS RELATION TO THE INDIVIDUAL AND THE STATE.

By Myra Brewster Clarke, A.B., A.M.*

The ancient Greek term, oeconomia, meant household management; but, the modern use of the term, economics, has been so far removed from the idea of the home that the combination of terms, Home and Economics, has seemed necessary to explain the scope and meaning of the course.

Home Economics is the scientific and aesthetic ordering of household affairs. It is the connecting link between the physical economics of the individual and the social economics of the state.

From the time of primitive peoples to modern civilization household activities have been important factors in racial development. The aim of the study of Home Economics, therefore, is not to train housekeepers and seamstresses, but, so to improve these household activities, by the study of the sciences and the arts connected therewith, that household conditions will be made better; the individuals within the home made healthier; happier and more efficient; and the state elevated, whose highest duty it is so to legislate and to administer its affairs as to make possible good homes.

The value of any subject is its worth for a certain purpose. It may be intrinsic or relative in comparison with other subjects. Home Economics fulfills this two-fold value in that it is helpful, first, to the individual, personally; and, second, beneficial to society in general.

The Value of Home Economics to the Individual.

Its helpfulness to the individual consists in the development of one's (1) intellectual, (2) physical, (3) moral nature.

(1). Intellectual Development for the Individual. The larger number of our words and thoughts refer back to sense impressions. In using her hands, for instance, to accomplish certain results, the girl receives vivid sense impressions which enable her to form clear conceptions, the co-ordination of muscles and mind resulting in mental discrimination. Reasoning, both inductive and deductive, is developed in the pupil's mind through the application of the underlying principles of chemistry, physics, physiology, sanitation, and the like. No other branch of hand work offers so rich a field for inductive reasoning as Domestic Science, because the natural forces involved make possible direct inductions from the applications of principles. The girl is constantly drawing comparisons between the causes of things and their effects, thus calling into activity the powers of judgment and discrimination.

The study of Home Economics not only enlarges the pupil's outlook on the life of to-day, leading to a better insight into modern civilization; but it also awakens an interest and sympathy in the great domains of art and industry.

Intellectual stagnation for the student of Home Economics, is impracticable because of the great number of correlations possible with such subjects as physics, chemistry, agriculture, biology, physi-

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ology and hygiene, sociology, economics of production and consumption, art, sanitation, textile industries, and anthropology.

(2). Physical Development of the Individual. On the physical side, the value of Home Economics is in hygienic well being and an increased efficiency in manual dexterity.

Mankind will best flourish where conditions for its development are most favorable. If an individual makes a study of hygiene; the sanitary conditions of air, food, clothing and surroundings; the nutritive value, digestibility, and economy of foods; she is more liable to take heed how she lives, what food she eats and how much, than one who has not studied the subject. Such a study will add to her social efficiency, for she is able to improve not only her own health, but that of her fellow beings, by teaching them to obey Nature's laws. The health of the rising generation may also be improved by teaching the children correct habits of life and giving them proper things to eat; for the food which the child gets will largely determine his health and well-being in after life.

The manual dexterity of pupils in Home Economics is greatly improved, for the hands execute what the mind conceives. The more perfect the impression, or mental image which exists in the pupil's mind, the more perfect the expression of it will be, mental discrimination and muscular habit going hand in hand. The constant repetition of processes makes for muscular control and perfects the ideal desired.

(3). Moral Development for the Individual. Morally the pupil in Home Economics will get a training in obedience to certain laws as well as commands; social ideals of courtesy, unselfishness, respect for the rights of others, justice, hospitality; accuracy; industry; orderliness and cleanliness; sense of responsibility in material things; perseverance and patience.

The human body in order to carry out its functions to the best advantage must be placed under the best sanitary conditions both as to food and environment. It has been proved, through studies in criminology, that a perfect physical life is the basis of a moral one. The theory that a sound body gives a sound mind is no idle one. The largest factor in the economics of to-day is the individual trained to the highest physical efficiency. It is only when the requirements of health are perfectly fulfilled, that there can be the greatest mental and moral efficiency of the individual; while the greatest loss of potential human energy occurs through an ignorance of, or a disregard of nature's laws.

The Social Value of Home Economics.

The social side of Home Economics has its influence on (1) home life, (2) school life, (3) society in general.

(1). Perhaps the greatest value of such a course of instruction is the social one, which deals with the fundamental principles of every day living. It considers such common subjects as what and how to eat; what and how to buy; what to wear and how to make it; how to be personally clean, and how to keep one's surroundings clean; how to house one's self; how to keep healthy.

The underlying thought of all courses in Home Economics is the betterment of home conditions through the application of science and art. It is the aim so to administer the household that the wel-

fare of the family as a whole and of the individual members constituting the family, is promoted, while at the same time civic conditions, in so far as they depend on healthful, moral family life, are enhanced.

(2). In considering the social value from the standpoint of education, perhaps the first question to ask is, "Do our present day conditions of society need or demand such training?" The answer can be easily determined by a brief review of schools, institutions, etc., teaching Home Economics, Domestic Science and Art, Household Administration and kindred courses, which are being introduced yearly in ever increasing instances.

1. Elementary Schools and Institutions.

(a). In more than fifty cities of the United States, Home Economics in some form is compulsory in the public schools.

(b). Mission schools, orphanages, schools for defectives, reformatories, etc., have cooking, sewing, hygiene, laundry and home nursing classes.

2. Secondary Schools.

(a). Public—High Schools throughout the country are introducing such courses either as compulsory or elective. Some State Normal Schools, of which Millidgeville, Ga., and the State Normal School at Framingham, Mass., are types, have courses in household arts as part of their regular instruction.

(b). Private—Girls' boarding schools, like the Castle-on-the-Hudson, and the industrial schools. like Hampton Institute, offer courses planned to improve home conditions.

3. Colleges and Institutions of College Grade.

(a). State and other Colleges. For instance, nearly all of the State Colleges of Agriculture and the Mechanic Arts, endowed by the Government, by Acts of Congress of 1862 and 1890, have courses more or less complete in this subject, such, for instance, as the Kansas State Agricultural College, where Home Economics instruction originated in the United States.

(b). Endowed Technical Schools. These include such institutions as the Carnegie Technical Schools, at Pittsburgh; Massachusetts Institute of Technology and Clarkson School of Technology.

(c). Colleges for Women. The typical woman's college has been somewhat undecided as to the introduction of Home Economics into the curriculum, feeling that it had not enough cultural value for the student. Nevertheless, some of them are now beginning to follow the trend of public sentiment in this respect.

4. Universities.

A few state universities, of which the University of Illinois is illustrative, offer courses in Home Economics. A growing number of endowed institutions of higher education, as Columbia University and University of Chicago, recognize the importance of such studies and afford them a place in their curricula.

5. Special Schools.

These are of two types; first, those institutions devoted purely and solely to household arts and sciences, such as The Boston Cooking School, The Philadelphia Cooking School, and The School of Domestic Science and Art at Chicago; second, such schools of technology as Pratt Institute, Brooklyn, or Drexel Institute, Philadelphia.

6. Other Agencies.

Numerous agencies interested in sanitation, hygiene and household management, besides the regular educational institutions, are at work all over the United States. These give instruction and conduct lectures under such heads as economic, sociologic, civic and domestic problems. The motive actuating these efforts is "the attainment of good health for the community and the dignifying and development of home life."*

A few of these agencies include summer schools, as Chautauqua; University Extension lectures, as conducted by the University of Chicago; Women's Clubs in the principal cities throughout the country; National Consumers' League; Farmers' Institutes in connection with the State Agricultural Experiment Stations, which were established by Act of Congress, 1888; settlement and neighborhood houses, as Hull House in Chicago; Educational Alliance in New York; and the Lake Placid Conferences.

(3). With relation, furthermore, to society in general, the study of the laws of economy, health, sanitation and sociology develops general social efficiency, with an appreciation for the dignity of labor. It makes better citizens and creates more perfect home conditions. "Not only do the household arts contribute to the life of the school the element needed to make it a real community life, but they surely lay the foundation for the future development that is not only to make of the individual an integral part of the social organism, but to implant in him that feeling of social responsibility that is to be so potent a factor in the regeneration of society."**

It is just as important for good citizenship that the child should be taught the rules governing sound health as that he should learn the rules of arithmetic. A well nourished body is like a bank account on which a person can not afford, and should not presume, to overdraw, any more than he would a financial account, lest disease or decay be the outcome.

A part of the common racial knowledge should be an understanding of the essentials of healthful living in order that the highest attainment of human progress may result. Individuals should be so educated in public and personal hygiene and sanitation that they will cheerfully support the city or state in enforcing sanitary measures.

When public opinion is so educated cities will be held responsible for the purity of air in public buildings and schools, the purity of foods sold in stores, and the healthful, cleanly conditions of their thoroughfares. Schools and colleges will then be required, also, to look after the bodies of their pupils as well as their minds. They will lay as much stress on having pure air, food and surroundings as they now do on having well equipped laboratories or libraries. The study of the relation of food and proper clothing to health will lessen the suffering due to diseases, will lower the death rate, and increase the productive power of the whole country.

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*Report of Mrs. Alice Ravenhill to the Technical Instruction Committee, Yorkshire, England.

**Mrs. Alice Norton, of the University of Chicago. Lake Placid Conference Reports, 1904.

A partial list of courses offered in the department of Home Economics is given below in detail.

Home Economics 1. Textiles. This course is designed to give students a comprehensive knowledge of the development of the textile industry, from the most primitive conditions to modern factories. Some practical work in weaving is also given, and constant reference is made to the present day school curriculum to show how it might be enriched by the application of a knowledge of textiles.

References:

Baldwin, "A Treatise on Designing and Weaving."
Beaumont, "Woolen and Worsted Manufacture."
Brooks, "Cotton Manufacture."
Dewey, "School and Society."
Dopp, "The Place of Industries in Elementary Education"
Earle, "Home Life in Colonial Days."
James, "How to Make Indian and Other Baskets."
Marsden, "Cotton Spinning."
Mason, "Origin of Inventions."
Mason, "Women's Share in Primitive Culture."
Meyer, "Handbook of Ornament."
White, "How to Make Baskets."
Wilkinson, "Story of the Cotton Plant."
Government Bulletins, Sheep, Wool, Cotton, Flax, Angora Goat.
Elementary School Record, Textile Number.
Teachers' College Record, Handwork Number.

Syllabus.

TOPIC I. Race development.

- (I) Evolution of primitive people.
  1. Animal stage.
  2. Hunting.
  3. Fishing.
  4. Pastoral.
  5. Agricultural.
- (II) Sources of information on race development.
  1. History and religion.
  2. Archaeology.
  3. Geology.
  4. Anthropology.
  5. Language and folklore.
  6. Handwork of primitive people.
- (III) Conditions causing development.
- (IV) Application to modern education.
  1. Development of child as race developed.
  2. Adjustment of child's work and experience to his environment.
  3. Correlation between learning and doing.

TOPIC II. Evolution of weaving.

- (I) Need of woven material.
- (II) Primitive looms.
- (III) Modern looms.
- (IV) Fibres in use.

TOPIC III. Evolution of spinning.

- (I) Beginnings.
- (II) Early inventions to aid process; spindle, distaff, whorl.
- (III) Wheels.
- (IV) Later inventions.
  1. Conditions in Europe before inventions.
  2. Inventions.
  3. Inventors.
  4. Modern processes.

TOPIC IV. Wool and woolen industries.

- (I) Nature of wool.
  1. Structure.
  2. Characteristics.
- (II) Sources of wool.
- (III) Supply for woolen trade countries.
- (IV) Production. Farms.
- (V) Manufacture.
  1. Processes for all wool.
  2. Development of card; processes and result.
  3. Combed wool industry.
  4. Worsted industry, differences between wool and worsted.
  5. Weaving.
  6. Finishing; wools, worsteds, special cloths as carpets.

(VI) Properties, uses and adulterations.
(VII) History.
1. Ancient times.
2. Modern times.
3. In United States.

TOPIC V. Cotton.

(I) Source and culture, structure.
(II) Treatment after growth.
1. Picking, ginning, baling, shipping.
(III) Countries growing cotton.
(IV) Industrial value of cotton in United States.
(V) Spinning and weaving.
(VI) Finishing.
(VII) Properties.
(VIII) History.

TOPIC VI. Flax.

(I) Botany, structure, culture.
(II) Spinning.
(III) Finishing.
(IV) Properties.
(V) History.
1. Ancient.
2. In United States.

TOPIC VII. Silk.

(I) Source, structure.
(II) Cultivation of silk worm.
(III) Reeling.
(IV) Spinning.
(V) Finishing.
(VI) Properties.
(VII) Adulterations.
(VIII) History.

TOPIC VIII. Dyes.

(I) Staining.
(II) Real dyeing.
(III) Mordants.
(IV) Effects on various fibres.
(V) Bleaching.

Home Economics 2. Laundrying. This course combines the theoretical and practical work in laundrying; the discussions of various scientific phases being followed by cleaning certain type of garments. The text in the students' hands is: Rankin, "The Science of Laundry Work."

References:

Balderson & Limerick, "Laundry Manual."
Parloa, "Home Economics."
Richards, "Cooking and Cleaning."

Syllabus.

TOPIC I.

1. Value of laundry work: sanitary and aesthetic.
2. Processes in laundrying.
3. Washing pillow-cases and towels.

TOPIC II.

1. Elements in laundrying: composition and uncleanness of fibres; purifiers.
2. Water: soft, hard; removal of hardness.
3. Ironing towels and pillow-cases: requirements for ironing; washing napkins and tablecloths.

TOPIC III.

1. Soaps: composition, kinds, properties, adulterations; soap powders.
2. Flannel experiments.
3. Sprinkling, ironing table linen; washing handkerchiefs.

TOPIC IV.

1. Wool: origin, structure, composition, properties, action of chemicals, manufacture, cleaning processes.
2. Ironing handkerchiefs; washing flannel garments.

TOPIC V.

1. Starch: source, composition, properties, use and proportions in laundrying.
2. Pressing flannels; washing and starching undergarments.

TOPIC VI.

1. Blueing: use, kinds, behavior of each.
2. Blueing experiments.
3. Ironing and washing undergarments.

TOPIC VII.

1. Cotton: source, composition. manufacture, action of chemicals.
2. Ironing undergarments, washing and starching skirts.

VOPIC VIII.

1. Dyes: kinds, sources, oxidation; cleaning of dyed fabrics.
2. Experiments in dyeing.
3. Ironing skirts; washing colored garments.

TOPICS IX and X.

1. Stains: causes, reagents, used, removal; use, sources, and composition of reagents.
2. Experiments in removing stains.
3. Ironing colored garments; washing stained garments.

TOPIC XI.

1. Flax: source, composition, properties, action of chemicals, manufacture; cleaning.
2. Ironing stained garments; washing doylies and centrepieces.

TOPIC XII.

1. Silk: source, composition, culture, manufacture, action of chemicals; cleaning.
2. Ironing doylies and centrepieces; washing silk garments.

TOPIC XIII.

1. Care of embroideries, laces, etc.
2. Ironing silk garments; washing point-lace handkerchiefs, drawn work stocks, etc.

TOPIC XIV.

1. Disinfectants: natural, artificial; reasons for disinfecting; use.
2. Ironing fine embroideries; washing shirt waist, stock, cuffs.

TOPIC XV.

1. Economy in laundry work.
2. Ironing shirt waist, stock, cuffs; washing stockings.

TOPIC XVI.

1. Rice starching.
2. Washing, clear starching, and ironing fine muslins.

TOPIC XVII.

1. Cleaning: woolens, silks, hangings, eiderdown, velvets.
2. Practical work on above.

TOPIC XVIII.

1. Private vs. public laundrying.
2. Visit to a public laundry.

Home Economics 21. Foods. The first year in cookery is based on food principles. The effect of heat on each principle is determined and this general notion is applied in the cookery of some material containing the food principle.

References:

1. Hutchinson, "Food and Dietetics."
2. Thompson, "Practical Dietetics."
3. Thudicum, "The Spirit of Cookery."
4. Williams, "Chemistry of Cookery."
5. Hill, Farmer, Rorer, Parloa, Larnard,—Cook Books.
6. Magazines, Good Housekeeping, Boston Cooking School, Ladies Home Journal.

Government Bulletins on Foods.

Syllabus.

I. Combustion.
- (I) Fuels.
  1. Solid.
  2. Liquid.
  3. Gaseous.
  4. Development of stoves.
  5. Electrical heating.
- (II) Heat.
  1. Temperatures.
     - a. Water.
     - b. Fats.
     - c. Oven.
  2. Transmission.
     - a Conduction.
     - b. Radiation.
     - c. Convection.

II. Carbohydrates.
- (I) Fruits.
  1. Fresh.
  2. Evaporated.
- (II) Starch.
  1. Cereals.
  2. Starchy vegetables.
  3. Sauces and cream soups.
- (III) Pectose and gums.
  1. Root vegetables.
  2. Fruits. Jellies.
- (IV) Sugar. Candy.
- (V) Cellulose.
  1. Green vegetables.
  2. Root vegetables.

III. Protein foods.
- (I) Proteids.
  1. Dairy products.
  2. Eggs.
  3. Shell fish.
  4. Fish.
     - a. Fresh.
     - b. Salt.
  5. Poultry.
  6. Meats.
- (II) Gelatines.

IV. Fats.

V. Combinations of food principles.
- (I) Batters and doughs, arranged according to leavening agents.
  1. Air and water.
  2. Air and carbonic acid gas from chemicals.
  3. Air and carbonic acid gas from yeast.
- (II) Salads.
- (III) Beverages.
- (IV) Ices.

Home Economics 22. Foods. This advanced course in cooking is for the purpose of applying the principles learned during the first year to more complicated cookery. Lessons are given in the preservation of foods, serving and planning menus, invalid cookery, costs and nutritive values of meals served, chafing dish cookery, and economy of foods.

Syllabus.

I. Fruits and vegetables.
1. Canning.
2. Preserving.
3. Jams and marmalades.
4. Jelly making.
5. Pickling.

II. Cheap cookery.
1. Meats.
2. Desserts.

III. Fancy cookery.
1. Breads.
2. Pastry.
3. Desserts.
4. Sugars, candy.
5. Chafing dishes.
6. Cakes.

IV. Demonstrations.

V. Invalid cookery.

VI. Meals.
1. Planning } breakfast
2. Cooking } and
3. Serving } luncheon.
4. Dietary value and cost of meals.

MOSQUITOES, MALARIA AND YELLOW FEVER.

By Homer M. Derr, A.M., Ph.D.*

Recently there has appeared in our technical journals considerable discussion on the mosquito theory of malaria and yellow fever. In most instances the writers favoring this theory are bacteriologists and sanitarians of note; on the other hand, some belonging to the engineering profession are inclined to ridicule the idea, without any unkindness of feeling, their only object being to correct wrong impressions, while others still are actuated by a more contemptuous spirit. Generally speaking, a blacksmith would not be expected to be able to make fine watches, neither could it be expected that a watchmaker should be able to shoe horses,—although he might be able to do so. Few engineers have studied the subject sufficiently to discuss it in a scientific spirit, and hence opinions advanced by them should be regarded with about as much weight as that of a bacteriologist upon whether the Panama Canal should be a lock or a sea level canal. No one should allow himself to become prejudiced from a lack of knowledge on the subject. It is a matter which should deeply concern every young engineer, whose services may at any time be in demand in the malarial and yellow fever districts of India, South Africa, Panama or other country. It has been estimated that the Panama railroad cost a life for every tie, due mainly to the ravages of yellow fever.

In view of the fact that the engineer sometimes has occasion to go into remote districts far from the reach of medical aid, it stands him in hand, then, to be his own physician. It will be well for him to make a previous study of the prevailing diseases of the country he expects to visit, and to take with him a generous supply of medicines to provide for the emergencies that may arise.

Nearly all of the infectious diseases are the direct result of the work of microbes. Skeptics are inclined to make light of the science of microbes, saying that remedies are available for some diseases the microbes of which are unknown and that we know the microbes of others for which we have no cure. Quinine was known to be a good remedy for malaria long before the microbe was discovered. Neither the smallpox microbe nor that of the vaccine which prevents it has been sifted out, but vaccination keeps the disease under control. On the other hand, the microbe of tuberculosis has been known for years, yet we have no sure cure for the malady.

It is true that the beneficial results of quinine in regard to malaria have been recognized for a couple of centuries; but what was not known was how to reduce the prevalence of the disease, which is far more important than knowing how to cure it. Some of our friends, the civil engineers, are claiming an undue amount of credit for the good work that has been accomplished along the line of drainage and sanitation, forgetting that such measures not only help to destroy the germs themselves, which were formerly supposed to arise from marshes, but that they have at the same time destroyed the breeding places of the carriers of the germs, the Anopheles mosquito. Men

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have known for centuries that malaria is in some way connected with stagnant water, and the good effects of drainage are evident; but it was not until a connection was established between the mosquito and malaria that we have been able to control the disease.

Although many observers have for years more or less vaguely noticed a relation between mosquitoes and malarial infection, the definite statement of the nature of this relation and its scientific demonstration are quite recent. Formerly it was believed by many that the various forms of intermittent fevers, yellow fever, and many other diseases, some of which are contagious, are produced by poisoned, infected, or bad air—in other words, by malaria. Our scientific knowledge of the subject has been almost entirely accumulated since 1898, and it has been absolutely and thoroughly demonstrated from every standpoint that certain species of mosquitoes belonging to the genus Anopheles, are the chief, and so far as known the sole disseminators of all types of malarial fever.

Malaria is one of the greatest scourges to which man is subject. Its cause is fully established to be a minute unicellular animal parasite of the class Sporozoa, living within the red blood corpuscles and introduced by the bite of a mosquito. Each well marked variety of malaria has its especial causal parasite, which passes through a complicated life-cycle,—as for example, the parasite of tropical malaria. The parasites enter the blood as minute slender sporozoites, penetrate red blood-corpuscles, and feed on the substance of the corpuscles and gradually destroy them. With the completion of their growth they undergo segmentation, each dividing into a mass of nucleated bodies (6 to 10) which escape into the blood-plasma by the disintegration of the red corpuscle. These free bodies seek and penetrate fresh corpuscles, whereupon the cycle begins anew, simultaneously with a paroxysm of fever. Most of the parasites continue this process repeatedly, but for some unknown reason a few assume a crescentic form and escape from the corpuscle without division. As long as the crescent-shaped bodies remain within the warm-blooded host they undergo no further material change; but if they are in any way removed, as into the stomach of a mosquito, they enter upon a second series of changes, undergoing a different history, however, finally lodging in the salivary glands around the mouth. When a mosquito harboring the parasites in this stage bites a susceptible human being some of the spores pass into the blood with the saliva and induce an attack of malaria, mild or severe according to their number and other conditions. Thus it will be seen that the malarial organism once introduced into the human system may continue to multiply indefinitely, but that it can be transferred naturally to another person only through the intermediation of a mosquito.

In the commonest form of malarial fever (the so-called chills and fever, or ague), after the parasites undergo an unknown period of incubation, ranging from 36 hours to 15 days, the patient has a feeling as though he were going to be sick, sometimes with headache, sometimes with a feeling of lassitude and a desire to yawn and to stretch. Frequently he has nausea and vomiting. At the same time the temperature has begun to rise and a chill commences. He begins to shiver, the face becomes drawn, thin, and cold, the body shakes, the teeth chatter, and the skin may be cold and blue, although the internal temperature is known to be gradually rising. After from

Fig. 1. Culex mosquito—(a) and (b) females; (c) male; (d) eggs; (e) young "wigglers"; (f) full-grown larva or "wiggler"; (g) larva in feeding position at surface; (h) pupa; all enlarged.

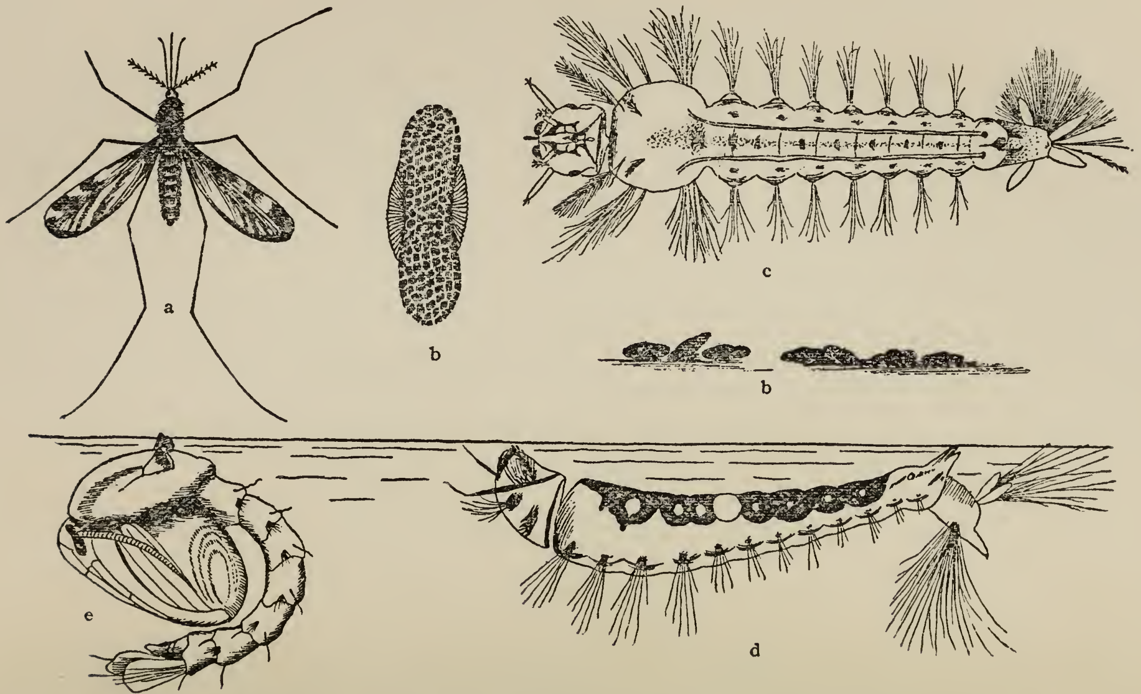

Fig. 2. Anopheles mosquito—(a) female; (b) eggs; (c) larva of "wiggler"; (d) larva in feeding position at surface; (e) pupa; all enlarged.

10 to 15 minutes, or perhaps a longer time, the chill is followed by a hot stage. The coldness of the surface disappears, and the face becomes congested and flushed, the skin is red, the pulse is full, and the patient may have a throbbing headache, with mental excitement. Thirst is excessive. Then the period of sweating begins, the whole body being covered with perspiration; the temperature drops, the headache disappears, and in an hour or two the paroxysm is over.

A number of variations from this typical form are known. In one type of fever the chill and fever usually occur every other day. This is due to the fact that the cycle of development of the parasite is about 48 hours and that the stage of full development of the parasite, or sporulation, which is more or less coincident with the attack, occurs at these times. Again every third day the patient may have an attack. In mixed infections, when two sets of parasites develop on alternate days, the paroxysms of chills, fever, and sweating may occur every day. In still another type of fever the cycle of development of the parasite is completed every fourth day. Mixed infections also occur in this form of the disease. These are the more common types of malaria in the northern United States. In the South a much severer form of the disease prevails, which gives rise to the so-called bilious remittent fever. The symptoms are extremely irregular. The paroxysms occur every 24 or 48 hours, and sometimes at greater intervals. The length of the paroxysms is usually longer, sometimes lasting 20 hours. The onset of the disease is usually gradual, and there may be no chill. Occasionally there is a continuous fever without much cessation, the temperature ranging from 102 to 103 degrees F. Jaundice is not infrequent, and this, with the fever, and a furred tongue and mental disturbance, often give rise to the suspicion of typhoid fever. In the simpler types the patient may get well after a short period without any special attention, but the more severe cases may prove fatal unless prompt medical attendance is provided. The specific quinine is a prompt and sure parasiticide, and should be used in all cases.

Malaria is most prevalent at the seasons of the year when mosquitoes are abundant; it thrives best in parts of the world where mosquitoes are most common; it is most likely to be caught at night, the time when mosquitoes are the busiest. It is to be noted, however, that not all kinds of mosquitoes are capable of being infected with the malarial parasite. Fortunately the common Culex mosquito (Fig. 1) is quite free from them and is, therefore, not a source of danger. Only the Anopheles mosquito is associated with this trouble. Fig. 2 shows the common form of this species. The difference between them are shown in the figures. The malaria-bearing mosquitoes may be readily distinguished, for they have wings which are more or less spotted and the projections on either side of their beak, known as palpi, are nearly as long as the beak, while in the Culex mosquitoes the wings are clear, and the palpi are very short (compare a and b, Fig. 1 and a Fig. 2). It must also be remembered that not all mosquitoes, even of the harmful species, will be dangerous. Only those that have sucked blood from malarial patients will contain the parasites and be able to transmit the disease. Only the female mosquito "sings" and "bites", and but few of these ever taste human blood, their normal food being the juices of plants. The males are readily recognized by their feathered antennae (compare b and c, Fig. 1).

In other words, of all the mosquitoes that bite us in summer only a few are likely to be infected and produce any trouble. We may be bitten thousands of times and still be free from malaria, while the next mosquito that bites us may inoculate us with these parasites. The danger is manifestly much greater in the tropics when we consider that there are great swarms of mosquitoes and that every native of those countries is thoroughly inoculated with the parasites from the day of his birth.

Those persons are best armed against malaria who are best protected against mosquitoes. If we live in a region where malaria abounds, it is dangerous to remain out of doors during the night, or even in the early part of the evening, unless properly sheltered. At this time mosquitoes are most likely to be flying about. From this fact arises the ground for belief that night air is dangerous. It is not the night air but the mosquitoes in the air that produce the trouble. It is also evident that the best method of protecting a household from malaria is the use of mosquito netting, inasmuch as the netting will keep mosquitoes from the houses and reduce the chances of contagion. The average so-called mosquito netting is of little or no use in the tropics where one's life depends in a measure on such protection. The prevailing kinds of mosquitoes will manage to wriggle through them, and experience has demonstrated that cheese-cloth is much more efficacious, at the same time allowing a free circulation of air. These precautions are not a matter of theory only, for it has been found by careful observation and experiment to produce a marked decrease in the amount of malaria in such regions. Rigid protection of houses to keep out the Anopheles is one of the most important procedures, and it is highly essential that the mosquitoes themselves should be kept from infection by screening all patients suffering from malarial fever. The patient's bed should be surrounded by mosquito netting, and all mosquitoes in the house should be killed by means of pyrethrum powder. Further measures for destroying malaria should be taken by draining off swamps and employing proper engineering methods in order to get rid of the mosquitoes themselves. The planting of swamps with leafy trees often dries them up, and thus prevents the formation of breeding places for mosquitoes.

It has been proved that yellow fever also is distributed by mosquitoes rather than by direct personal contagion. The species of mosquito is different from either of those shown in Figs. 1 and 2, and lives only in warm climates. Mosquito netting is the best check for this disease also. Yellow fever was almost wholly stamped out of Havana by simply surrounding the patients with netting, thus preventing the mosquitoes from biting them and becoming infected with the germs which they might carry to other persons.

In order that we may deal more intelligently with this question let us look into the life-history of the mosquito. First of all, they must have water in which to breed. A puddle of water in the roadside left by a passing shower may, in a week's time, furnish a breeding place for hundreds of "wigglers" or larval mosquitoes (e and g, Fig. 1, and d, Fig. 2). Rain-water barrels and tubs around country homes are common breeding-places for mosquitoes. They also breed in almost any place where water stands for a fortnight, and often swarm in small ponds and in quiet pools along the borders of streams or about springs. Mosquitoes delight in dark and damp places where

the air does not freely circulate, as in tall grass underneath trees; but they do not breed in such localities and must have come from some near-by water.

The common household mosquitoes hibernate in the adult or winged form. The eggs of the common Culex mosquitoes are laid on end in raft-shaped masses, which float on the surface of the water (Fig. 1, d), while those of Anopheles are laid singly on their sides (Fig. 2, b). Most persons are familiar with mosquito larvae or "wigglers" which wriggle about in the water, returning at frequent intervals to the surface to breathe, and when at the surface hanging with simply the tip of the tail, which is the breathing tube, the rest of the body being held below the surface (Fig. 1, g). The "wigglers" eat minute particles of decaying vegetable matter and living algae in the water; some of the larger kinds are carniverous and eat their smaller relatives. The malarial "wigglers" rest most of the time at the surface with their body parallel to the surface, and not hanging down as does the Culex "wiggler". (Compare Figs. 1, g, and 2, d). The eggs may hatch the same day they are laid, and the "wigglers" may get their full growth (Fig. 1, f) in a week, when they transform to the active, large-headed pupae, shown at h in Fig. 1. The pupal state may last only one day, so that an entire generation of mosquitoes in summer time may be completed in ten days. Most of the mosquitoes which come into houses, except near the salt-marsh lands along the seashore, are doubtless developed in water not more than two or three hundred yards away. The salt-marh mosquitoes often migrate several miles, and sometimes other forms may be carried by steady, light winds for considerable distances.

There is now a world-wide crusade against mosquitoes. This is due to the practical demonstration that certain kinds may transmit malaria, yellow fever and probably other diseases of human beings. The warfare against mosquitoes consists largely in destroying their watery breeding grounds. This can be done on a large scale either by draining or filling in marshes, pools and similar places which often swarm with the "wigglers". Large areas of such mosquito-breeding waste lands in New Jersey and on Long Island are thus being reclaimed, and the mosquito nuisance largely abated. Another practical and successful method is to pour or sprinkle kerosene oil or crude petroleum every two or three weeks in a thin film over the surface of cesspools or rain-barrels, tanks, ponds or any other body of sluggish water where the "wigglers" are found. This oil-film kills the "wigglers" (both larvae and pupae), by preventing them from getting to the surface to breathe (Fig. 1, g), and it also prevents the mother mosquito from laying her eggs on the water. By a little concerted effort of local authorities in applying whichever methods are most practicable, much good could be accomplished and the pestiferous mosquito largely eliminated in many localities.

SOME STRUCTURAL PROBLEMS IN THE NEW YORK TIMES BUILDING.

By Charles H. Lawrance.*

The New York Times Building, at the corner of Broadway, 7th Avenue and 42nd St., New York, is probably the most extreme example of the modern skyscraper in the city. Occupying a triangular plot of ground, 137 ft. 9 in. long by 58 ft. 4 in. at the base, it rises 362 feet above the sidewalk and extends 55 ft. below the level of the same; in other words, its total height is about 7¼ times its width. Below the street level it extends under the sidewalk to the curb, on all sides, and the area of the floors below the ground is almost as much as the floor area above.

Probably the first questions that suggest themselves to a person on seeing this building are, How is the foundation bedded? and How can the structure stand against the wind?

These, of course, were among the most important problems to be solved by the engineers when the building was designed. The problem or the project, as it may be called, of the building itself, was sufficiently difficult, from the fact that never before had there been a structure erected quite so tall and slender. There had been no precedent established from similar constructions. An added difficulty arose from the fact that the Subway runs obliquely through the basement of the building, and the Rapid Transit Commission had the supreme right of way, which forbade any obstruction to the alignment of the Subway tracks.

The floor of the Subway being about 20 feet below the curb, and the basement of the Times building about 55 feet below the same level, permitted of the basement extending completely underneath the Subway and necessitated carrying the Subway on columns from the basement floor. It was deemed necessary to keep the foundations of the railroad separate from those of the building, partly because one was a public and the other a private work, and therefore inadvisable to carry them on the same supporting members; and, partly for the reason that if any jar or shock resulted from the moving trains it would otherwise be transmitted to the structure above. A method was devised by which the owners of the building were to design the same, and the owners of the railroad to design the railroad, so that the two should be entirely separate and distinct. This plan has been carried out, and now the railroad goes through the building practically without touching it. Not one piece of iron or concrete of the one structure touches the other. A space of about two inches surrounds each Subway column where it passes through the building and the same space surrounds each column of the building where it passes through the Subway.

The location of the columns in the basement was governed by the location of the Subway, while in the building above they were required to be in a different position. This difficulty was overcome by placing the columns to the height of the Subway roof where they could best be located, under the circumstances; and, spanning the space overhead with large plate girders, carrying the columns above on these

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girders. Part of these girders are what is known as of the cantilever type, being supported at one end and at some other point than the end, and carrying a large part of their load at the unsupported end.

In one case it was calculated that, for extreme cases of loading and wind pressure, the load on the cantilever end would be so great as to give an upward pull on the opposite end; and that, for the time being, the column below on the opposite end would act as a tie instead of a strut. This would throw on the other supporting column the combined load of its own normal load, the normal load of the other supporting column and the force with which the other column was pulling down. For this reason this column was designed to carry safely the enormous load of 1500 tons. It has a cross section of 258 square inches and is composed of 16 separate pieces. It extends thro' the Subway, between the tracks; and, since it was limited in thickness to 1 ft. 3 in., perpendicular to the tracks, it had to be made 3 ft. 6 in. wide, so as to get room to rivet the different members together. Its length is 41 ft. 5 in., and it weighs 19 tons. The girder which this column carries is the heaviest for its length ever used in building construction. It is composed of three separate built up I-beams; and, in order to take the great load that comes upon it, each beam has three heavy web plates with correspondingly heavy flanges.

In getting the load on each column, the weight of every piece of floor or part of wall, brick, stone, covering of column, and the weight of the column itself were carefully calculated; and, to this was added the load due to the wind. This work was done with great exactness and the total loads thus obtained were used in designing the footings for the columns.

While the foundation in general was quite simple yet it offered two interesting problems. The excavation, 55 feet deep (almost enough for the construction of an ordinary 5-story building), extends for about three-quarters of its depth through solid gneiss rock; and, the bottom is well below the action of any disintegrating influences. The columns rest on cast-steel bases, 4 or 5 feet square, and these in turn are carried on granite blocks, 8 feet square and 2 feet thick, which rest upon the solid rock leveled perfectly smooth with Portland cement. The steel bases are set in copper pans which connect with the waterproofing, and in this way are protected from moisture and stray electric currents which otherwise might cause rust and electrolysis. It also effectually grounds the steel framework and makes it as lightning-proof as it is possible to make this class of building.

The columns of the Subway and of the building are so close together, in some places, that it was thought advisable to adopt some means of preventing vibration from the moving trains from being communicated to the building through the foundation. It had been amply demonstrated in other buildings, that a foundation on the rock would transmit to the building vibrations which the same rock received directly from trains or machinery. The way this was prevented in the Times Building was by bedding the important Subway columns in sand. A hole in the rock considerably larger than the footing itself was excavated, and the foundation built in such a way that there remains a cushion of sand a foot thick between the footing and the rock. The result was very satisfactory as was shown by a rather odd test made just after the building was completed. In its basement as near

the rock as possible and close to the foot of one of the Subway columns, a bowl of water was placed in such a position in relation to an arc lamp that the slightest ripple on the water would be magnified by reflection. The water was so sensitive a medium that it would reflect the jar from a person walking near it on the hard cement floor. It was found that the passing of an express train overhead produced no more of a tremor in the water than a person walking within a few feet of it. The experiment was repeated by placing the bowl on a window sill, just above the Subway, in which position a passing street car, or loaded truck on the street gave more vibration than a Subway express train.

The other problem was due to the fact that the strata in the underlying rock runs north and south, and is nearly vertical, tipping slightly to the east. The heavy blasting required for breaking up the material shattered and loosened this rock for long distances. For this reason, on the east side of the property, large pieces of rock extending out under the street were loosened along the line of stratification, and several of them slid into the excavation. To prevent any further slips that might occur after the building should be finished, a retaining wall was built, strong enough to withstand any strain that might come upon it. This was done by building into this wall 24-inch steel I-beams, standing vertically, spaced 3 ft. 6 in. on centres. They extend 5 feet below the basement floor and have their bases bedded in concrete. The thrust at their upper ends, just under the Subway, is held by a floor of steel beams, with concrete arches between, connecting with interior columns at that level, and extending across the building and bracing into the wall on the other side. While the bracing effect of this retaining wall was not calculated to be effective in wind bracing, nevertheless it proves really a great help. for the building practically stands in a hole in the rock and is thus thoroughly braced against the sides in every direction. This leads directly to a consideration of the problem of wind bracing.

The isolation of the building and the unusual proportion of height to width made the problem of wind bracing one of the utmost importance. Resistance to the wind is attained by stiffness and dead weight. From the fact that the building has been calculated to weigh 39,000 tons, empty, or about 41,500 tons, with machinery, etc., it can be readily calculated that there is absolutely no danger of the building being blown over bodily, so that the task then remaining for the engineers was to make the frame work rigid. The building is calculated to withstand, with a large factor of safety, a steady wind pressure of 30 pounds per square foot of surface, on the exposed face. This is far beyond the pushing force of a tornado. Although heavier pressures than 30 pounds have been recorded they occur only in momentary gusts, and would be amply taken care of by the inertia of the building.

The components that make up the resistance to the wind pressure are the inertia of the structure, stiffness of floors and partitions, depth of beams and stiffness of their connections to the columns, and three different systems of transverse bracings proportioned to take definite calculated loads and transmit them to the columns. The three systems are the gusset construction, the knee-brace construction, and the diagonal construction. The gusset construction is used all around the outside of building, at all floors, and is principally employed to give rigidity to the whole structure. The other two types

are placed at different points in the building, their whole purpose being to resist the horizontal thrust of the wind.

The strength of the building in respect to wind bracing is calculated to be found in the steel framework, but with the addition of inertia, stiffness of floors and partitions, and the bracing of the beams at and below the sidewalk, all of which are indeterminate, the ultimate resisting power may be safely assumed to exceed, by a large margin, any load that will ever come upon it. In the opinion of experts the Times Building is the strongest and stiffest steel frame structure of its kind ever erected.

NEW COURSES OF INSTRUCTION, 1905-1906.

Economics of Industry. Economics 3. This course is given for the first time to the present junior class. It comprises an economic study of resources and their utilization, industries and their development, and of machinery and transportation. Prerequisite, Economics 1. Lectures, reports. I.; Th. 1; (1). Director Aldrich.

Mechanical Engineering. M.E. 15. Steam Turbines. This course is offered for the first time this year, and required of seniors in electrical and mechanical engineering. It embraces a study of the principles involved in the design of the steam turbine; e. g., the flow of steam through nozzles and blade channels; the choice of peripherical velocities, angles and steam velocities; work lost in friction, etc.; a discussion of the construction of the most important parts; the regulation; the adaptation of the steam turbine to the various purposes, as power plant practice, navigation and traction. The current engineering literature is closely followed in this connection, and the published results of tests and installations of steam turbines are discussed, always with reference to the other forms of prime movers, the reciprocating steam-engine and the internal combustion engine. Prerequisite, M.E. 13, Heat Engines. I.; Th. 2; (1). Professor Willhofft.

Modern History and Current Topics. History 1. This course is chiefly devoted to the serious study and aggressive discussion of vital questions—social, economic and political—so as to keep in touch with present movements. No text-book is used, but standard magazine and newspaper articles, important news of the week and month, and news that bear upon the progress of the world are made the basis for study, investigation and discussion. II.; arrange time; (2). Prof. Michel.

History of Philosophy. History 2. While we may regard the philosophical doctrines simply as so many contributions to truth in the evolution of thought, yet their influence as evolutionary and vital forces in determining the literary, social, political and industrial life of the world is evident. The chief aim of this course will, therefore, consist in tracing our modern doctrines and thoughts to their sources by investigating old and modern philosophic doctrines with regard to psychology, ethics, cosmology, theology, metaphysics, biology, anthropology, political government and moral science (practical philosophy), scientific doctrines, etc. The work will be based on "Turner's History of Philosophy" with parallel readings, comparisons, study and discussion of extracts selected from standard works and essays, such as "The Immortality of the Soul," "The Standard of Life," "Relations of Mind and Brain," "Mind in Evolution," "Theory and Foundations of

Knowledge," "Philosophy and Life," "The World and the Individual," "The Basis of Morality," "Morality as a Religion," "Mental Development in the Child and the Race," etc. II.; arrange time: (1) or (2). Professor Michel.

Civil Engineering, C. E. 21. City Surveying. Precise methods of measuring distances and angles; city surveys; mining survey methods. Prerequisite, C. E. 2. Recitations, field work, drafting and computations. I., first twelve weeks; Saturday, 9 hours; (2). Professor Derr.

Civil Engineering, C. E. 3. Lettering, Tinting and Shading. Freehand lettering for working drawings, maps, etc. Rendering in water color, sepia and india ink. I., last six weeks; arrange time; 9 hours; (1). Professor Derr.

Home Economics 23. Economic Entomology. A study of the more important household insect pests, including the use of insecticides and preventive remedies. Insect anatomy, metamorphosis, habits and classification. Laboratory work and assigned reading. I.; F., 5, 6, 7, (2). Professor Derr.

DEPARTMENT NOTES.

Mechanical Engineering, M.E. 7. Gas Engines. This course has been shifted from the junior to the senior year, and is required of all students in Electrical and Mechanical Engineering. It is treated in the same way as the course in Steam Turbines, M.E. 15, described above. In fact the two courses taken together might be called "modern power plant practice." the reciprocating steam engine always coming in for comparison.

Mechanical Engineering Laboratory. The seniors, last year, assisted by the juniors, after some ten-hour tests of the boiler and engine equipment of the Clarkson School, made a very interesting fourteen-hour test of the power plant of the Remington-Frost Paper Mill, at Norfolk, N. Y.; also, a test of the power station belonging to the Electric Light and Traction Company, of Ogdensburg, N. Y. A visit of inspection was made to the plant of the Racquette River Paper Co., located at Sissonville, near Potsdam. It is intended to make as many of these tests as practicable, for it is believed that a student will derive a great deal of benefit from being confronted with actual conditions, where he meets obstacles of all kinds. While during the junior year the students are taught the use of instruments and the method of testing, in the senior year they are required to plan and carry out actual commercial tests. At present the seniors are making a series of engine and plant tests in the Marble Quarries and the Lace Factory, of Gouverneur, N. Y., and in the mines in the neighborhood of Hermon, Pyrites, Keene, etc. In this way they become acquainted with numerous types of engines, transmission and other machinery.

The Automobile School. This was connected with the Summer Session of the Clarkson School, and proved to be a very successful venture, although it had not been widely advertised. The young men who took the course acquired not only skill in operating an automobile, but a training such that they should also be able to take complete charge of a machine, and to execute intelligently all the ordinary repairs and adjustments. The chassis of the Rambler 18 HP. Surrey, which was kindly loaned by the company, is at present being prepared

for a thorough efficiency test in the Mechanical Engineering Laboratory. It is intended to make a series of investigations on this machine, including a comparative test of carburetters, determination of the volumetric efficiency at high speeds, the power absorbed by the transmission and the muffler, etc.

Mechanical Construction. Shopwork 12, now taken by the senior students in the Mechanical and Electrical Engineering courses, comprises several practical pieces of work. Messrs. Phelps and Perkins are completing the induction motor begun last year by Messrs. Stack and Dunsford. Messrs. Cummings and Leonard are completing the 5 HP. motor begun by former students. Mr. Burrows has almost completed the taper attachment designed for use on one of the engine lathes by a former student in the class in Machine Design of two years ago. A counter shaft, for use with one of the small bench grinders made in the shops last year, is being constructed by Mr. McIntyre; and Mr. Murdock has nearly finished a small vise for use on the drill press. Several pieces of apparatus and repair work are under way, and some have already been completed.

Machine Drawing. The junior class in Machine Drawing has nearly completed the first set of detail drawings and will soon start on interesting and complicated work, of the nature of machine and electrical design. The complete designs and drawings for a small induction motor will also be taken up.

NOTES OF THE STUDENT ORGANIZATIONS.

Young Men's Christian Association. The work of the Association began with the opening of the school year and under favorable auspices Through the energy and zeal with which the returning members entered upon their work, several new members have been enrolled; a card of topics has been issued, covering the meetings during the first semester; and it is proposed to offer a series of lectures and talks by professional men to be given at various times during the winter, so that there is every indication that the work of the year will be marked by results.

The Association held the first social event of the school year, Friday evening, Sept. 29, 1905, a reception from eight to twelve o'clock, at the Tech. Club House, on Fall Island. It was the first reception in its history and a marked success, being well attended by members of the Board of Trustees, the Faculty and the entire student body. After the introductions incident to the occasion, the Welker brothers, Loy and George, accompanied by Miss Corinne M. Frame at the piano, rendered several choice selections on the violin, which were repeatedly encored. With college songs, whistling solos with piano accompaniment, and cleverly arranged games. the evening wore on and closed with refreshments, delicately prepared and tastefully served by the young men, members of the Association, unaided, it is said, by the specially trained experts of the School in Domestic Art. The decorations of the club rooms were autumn leaves among which the red maple predominated.

The following officers have been elected for the ensuing year.

Charles S. Merriman,, '08.....President.
Grant Tracy, '08............Vice President.
Frank H. Flint, '06..........Secy. and Treasurer

Y. M. C. A. Topics, 1905-6.

Sept. 29—Faith, Meacham.
Oct. 6—Supplied, Merriman.
Oct. 13—What is Practical Christianity? Simpson.
Oct. 20—A Man's Strength, Tracy.
Oct. 27—The Power of Habit, Moulton.
Nov. 3—Minor Moralities, Perkins.
Nov. 10—What a New Student Expects from "Tech" and Community, Cochrane.
Nov. 17—What the "Tech" and Community Expects from the Students, Prof. Graffam.
Nov. 24—What Christ Expects from us all, Hardenbergh.
Dec. 1—The Power of Little Things, F. Flint.
Dec. 8—The Building of a Character, A. Flint.
Dec. 15—Illustrated Lecture, Prof. Derr.
Jan. 5—The Making of a Christian, Roulston.
Jan. 12—To be Announced.
Jan. 19—The Power of Little Things, Safford.
Jan. 26—Our Debt to the World, Meacham.

Clarkson Athletic Association. The annual meeting of the Association was held October 9, 1905, and the following men were elected as officers for the current college year:

Francis P. Cummings, '06.. .. .. President.
Floyd R. Finch, '07.. .. ..Treasurer.
David D. Thompson, '07.. .. ..Secretary
Jean H. Hawley, '07.. .. ..Base Ball Manager.
Ralph B. Leonard, '06.. .. .Basket Ball Manager.

A great deal of interest is being shown in basket ball and base ball in which there seems to be at present a large amount of material in the school. Managers of respective teams say that the material is exceptionally good, and they promise us many surprises before the seasons are over.

Clarkson Musical Association. The following officers have been elected for the ensuing year, at a meeting of the Association held Oct. 2, 1905:

Charles D. Owen, '06.. .. ..President.
David D. Thompson, '07.. .. ..Vice-President
Rufus L. Safford, '08.. .. ....Sec'y and Treasurer

These officers, together with those of the three other clubs, form the Board of Directors of the Association.

The Glee Club consisting of twenty members, meets each Tuesday evening for rehearsal, under the leadership of Charles D. Owen, '06; Abel Simpson, '06, is manager. The Orchestra consists of eleven members, meeting Wednesday evenings, under the leadership of Loy E. Welker, '09; George E. Welker, '09, manager.

Sigma Delta Fraternity. At the opening of the school year this fraternity occupied its new home, at 22 Leroy street. The building is centrally located, and well adapted for use as a fraternity house. The undergraduate members of last year have returned and a majority of them have taken up their quarters in the house.

RECENT APPOINTMENTS OF CLARKSON GRADUATES.

1900.

Charles H. Lawrance, B. S. in Electrical Engineering, Instructor in Drawing and Design, North Carolina College of Agriculture and Mechanic Arts, West Raleigh, N. C.

1902.

William G. Evans, B. S. in Civil Engineering, South Park Commissioners, 57th St. and Cottage Grove Ave., and for mail, 365 LaSalle St., Chicago.

Sanford C. Humphrey, U. S. Engineer's Office, Wellsville, Ohio.

1903.

George G. Sweet, (A. B., Cornell University, 1901), B. S. in Civil Engineering, Chicago & Northwestern Railroad Co.

1905.

Harry B. Claflin, B. S. in Electrical Engineering, Manager Sales Department, Potsdam Electric Light & Power Co., Potsdam, N. Y.

Clinton A. Curtis, B. S. in Civil Engineering, Engineer Corps, New York State Barge Canal, and for mail, 326 Germania Ave., Schenectady, N. Y.

Harold S. Dunsford, B. S. in Electrical Engineering, Testing Department, General Electric Co., and for mail, 818 Lincoln Ave., Schenectady, N. Y.

Lloyd W. Greene, B. S. in Civil Engineering, R. W. & O. Division, New York Central Railroad Co., and for mail, 23 Burchard St., Watertown, N. Y.

Chester E. Hudson, B. S. in Civil Engineering, in charge Engineering Department, Manufacturing Automatic Sprinkler Co., 310 Weld Building, Boston, Mass., and for mail, 4 Michigan Ave., Dorchester, Mass.

Albert L. Sayer, B. S. in Civil Engineering, with Wallace C. Johnson, Consulting Engineer, Niagara Falls, N. Y. and for mail, Ogdensburg, N. Y.

Michael L. Stack, B. S. in Electrical Engineering, Stanley—G. I. Electric Manufacturing Co., and for mail 193 Woodlawn Ave., Pittsfield, Mass.

Silas S. Stone, B. S. in Electrical Engineering, Testing Department, General Electrical Co., and for mail, 508 Schenectady St., Schenectady, N. Y.

Abram T. VanHorne, B. S. in Civil Engineering, with J. L. Dodge, Middletown, Md.

ALUMNI PERSONALS.

1900.

Julius R. Jacobson, with the General Electric Co., Schenectady, N. Y., sailed for Brazil, Sept. 5, 1905, to superintend the construction of an electric power plant for the company, in a gold mining industry, about five hundred miles from Rio Janerio.

Charles H. Lawrance, who contributes the article in this issue of the Bulletin, on "Some Structural Problems in the New York Times Building," has been intimately associated with some

of the engineering and architectural features of this remarkable building, and has been thoroughly familiar with all of the structural problems encountered. He was with the firm of Purdy & Henderson, Architects, New York City, till recently appointed Instructor in Drawing and Design, North Carolina College of Agriculture and Mechanic Arts, West Raleigh, N.C.

1901.

Robert T. Danforth has been appointed Assistant General Superintendent, of the St. Lawwrence River Power Co., Massena, N. Y.

Norman L. Rea, with the General Electric Co., Schenectady, N. Y., has recently installed a power plant in Vermont to be equipped with Curtis steam turbines and electric generators made by the Company. He is at present installing a water power plant for the Vermont Marble Co.; one-third of the power will be used in the mills, at Proctor, and the remainder transmitted to West Rutland and Alberton, for the mills at those places.

John E. Harriman, with the Telephone Construction Co., of Kansas City, Mo., is at present engaged on work for the Citizens Tile Co., of St. Joseph, Mo.

1902.

Wait R. Loveless, Electrician, Pennsylvania Railroad Co., is in charge of motors and incandescent lighting service of the Altoona shops of the Company.

Rea M. Gordon has been elected to Junior Membership in the American Society of Mechanical Engineers.

1903.

George O. Hodge has been elected to Junior Membership in the American Society of Mechanical Engineers.

1904.

Frank C. Zapf, Analyst, General Electric Company, Schenectady, N. Y., has been employed recently upon special work in the study and examination of alloys, coals and coke.

ENROLLMENT OF STUDENTS. I Semester, 1905-1906.

Engineering Courses:	Seniors	12
	Juniors	10
	Sophomores	14
	Freshmen	20
	Specials	2
Home Economics:	Seniors (Baccalaureate degree Course)	2
	Second Year, (Certificate Course)	3
	First Year, (Certificate Course)	7
	Specials	1
	Total	71

WEATHER REPORT.

REPORT TO SEP. 30, 1905. Observations made at Clarkson School of Technology, Potsdam, N. Y.	AVERAGE. Temperature. Max.	Min.	Mean.	Barom inches.	TOTALS. Precip. inches.	Snow inches.
Month ending Apr. 30, 1905	53.0	31.6	43.0	29.43	2.76	
" " May 31,	66.1	44.7	65.5	29.57	3.32	
" " June 30,	75.5	53.4	64.7	29.59	5.57	
Week ending July 1, 1905	76.0	52.0	63.9	29.55	1.41	
" " " 8,	84.4	64.7	74.5	29.60	2.38	
" " " 15,	83.5	62.2	73.0	29.68	0.20	
" " " 22,	81.2	57.2	69.0	29.54	2.10	
" " " 29,	77.0	56.0	66.4	29.48	0.93	
" " Aug. 5,	74.0	53.4	63.6	29.56	1.60	
" " " 12,	83.0	62.5	72.7	29.58	0.90	
" " " 19,	73.8	50.3	62.0	29.67	0.83	
" " " 26,	77.7	54.0	65.8	29.58	0.29	
" " Sep. 2,	72.2	50.2	61.2	29.58	1.48	
" " " 9,	73.2	52.2	62.7	29.67	0.81	
" " " 16,	69.1	47.1	58.1	29.73	0.60	
" " " 23,	75.1	56.1	64.9	29.57	0.63	
" " " 30,	68.3	40.4	53.6	29.64	0.07	
Month ending July 31,	80.2	59.7	69.9	29.55	7.47	
" " Aug. 31,	77.2	54.3	65.3	29.61	3.58	
" " Sep. 30,	71.3	49.0	59.9	29.66	2.06	

The precipitation includes all rain fall and snow melted.

THOMAS S. CLARKSON

MEMORIAL

SCHOOL OF TECHNOLOGY

POTSDAM, N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language and literature, the applied and economic sciences, engineering and technology. They lead to the degree of Bachelor of Science in the major course pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical and mechanical engineering. The instruction taken in common during the first two years provides the elements of a liberal edncation. Based upon similar instruction in the fundamental principles of engineering science, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting tests and researches.

The technical instruction of the last two years, in the theory and practice of engineering, affords the student substantial preparation for immediate usefulness in engineering workshop or laboratory, office or field, by intelligent application of principles to the successful mastery of his field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their chosen profession.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

CLARKSON BULLETIN

Vol. III. JANUARY, 1906. No. 1.

THOMAS S. CLARKSON
MEMORIAL
SCHOOL OF TECHNOLOGY

POTSDAM, N. Y.

ISSUED QUARTERLY BY

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

Entered January 16, 1904, at Potsdam, N. Y.,
as second-class matter, under Act of Congress,
of July 16, 1894.

1906

Thomas S. Clarkson
Memorial
School of Technology

(Copy of the original charter.)

UNIVERSITY OF THE STATE OF NEW YORK

CHARTER OF

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

Whereas, A petition for incorporation as an institution of the University has been duly received, and

Whereas, Official inspection shows that suitable provision has been made for buildings, furniture, equipment and for proper maintenance, and that all other prescribed requirements have been fully met

Therefore, Being satisfied that public interests will be promoted by such incorporation, the Regents by virtue of the authority conferred on them by law hereby incorporate

Elizabeth Clarkson, Frederica Clarkson, Annie Clarkson, Abraham X. Parker, John G. McIntyre, George H. Sweet, Edwin A. Merritt and their successors in office under the corporate name of Thomas S. Clarkson Memorial School of Technology with all powers, privileges and duties, and subject to all limitations and restrictions prescribed for such corporations by law or by the ordinances of the University of the State of New York. The first Trustees of said corporation shall be the seven above named incorporators. This corporation shall be located at Potsdam, St. Lawrence County, New York, and may grant diplomas to all students who complete the regular courses of instruction, and certificates to those completing special work. All graduates who shall have satisfactorily completed the course of study and the examinations required and shall have been recommended by the Trustees for the degree of Bachelor of Science, shall receive from the University the degree B.S. certified by a diploma bearing the seals and the official signatures both of the institution and of the University of the State of New York.

In witness whereof, the Regents grant this charter No. 999 under seal of the University, at the Capitol in Albany, March 19, 1896.

(Signed) Anson Judd Upson, Chancellor.

(Signed) Melvil Dewey, Secretary.

1896 — DECENNIAL YEAR — 1906

Clarkson Bulletin

Vol. III. January, 1906. No. 1.

CONTENTS OF THIS NUMBER.

Announcement: The Clarkson Bulletin is published quarterly
It will be mailed upon application to

The Director,

Clarkson School of Technology,

Potsdam, N. Y.

TECHNICAL EDUCATION OF THE XXTH CENTURY.

By John Cassan Wait, M.C.E., LL.B.*

Mr. Director, Board of Trustees, Faculty, Students and Friends of the Thomas S. Clarkson Memorial School of Technology:

I am to address you this evening upon the subject of

"TECHNICAL EDUCATION OF THE XXTH CENTURY."

A poet has said,

"Turn back the tide of ages to its head,
And hoard the wisdom of the honored dead."

Is not this the essence of modern education,—to uncover, disclose, accumulate, and then dispense the knowledge of the past, rather than to cultivate original research and investigation,—to school the student in the past, in the belief that what has been is the safest guide of what is and is to be,—to treasure the harvests of the past for use in the cultivation of the future?

Herman Kopp has said,

> "It is not in our power to appropriate to ourselves the experiences and results which the future alone can bring. But in a common sense we are enabled to prolong our life backward into the past by appropriating the experience of those who were before us and by becoming acquainted with their views as thoroughly as if we had been their contemporaries. The means of doing this is an elixir of life."

Technical education in all industrial branches requires that the scholar should be or become familiar with Nature, her phenomena, resources and laws. This is possible, for,

> "Nature will be reported. All things are engaged in writing their history. The planet, the pebble, goes attended by its shadow. The rolling rock leaves its scratches on the mountain; the river, its channel in the soil; the animal, its bones in the stream; the fern and leaf, their modest epitaph in the coal. The falling drop makes its sculpture in the sand or the stone. Not a foot steps into the snow or along the ground but prints its characters, more or less lasting, a map of its march."

The foundation of a technical training consists of nature's laws and phenomena, and as nature's laws are fixed and inexorable, a student possessed of a knowledge of what has been, knows what will be, and it is this that forms the ground-work of the XXth century system of education. But this is not all; it should go further; it should elevate the new generation to a higher plane than mere investigation; it should cultivate powers, a higher ideal and a struggle for genius, the divine, the creative.

An education implies first, a student or scholar to be educated, second, a process or method by which the education is to be acquired, and third, an ulterior purpose or ultimate utilization of the educa-

*Member American Society Civil Engineers, Attorney and Counsellor at Law, New York City.

tion to some good aim and end. I will subdivide my subject generally under these three headings.

First. The Pupil or Student. The average American youth is, when he or she comes to your institution, a well known quantity. He or she has not been schooled, trained and weighed and compared with a petty well defined standard. Your students were not born alike. Those who were usually bright have been restrained; the dull ones have been crowded forward. All are now like members of a corps of intellectual cadets. They have climbed the same ladder to mount the examination barrier and have followed in "lockstep" order, rung after rung.

At the beginning of the last century no such army of pupils existed in this country. The secondary schools were not graded and the requirements for the colleges were not well defined. Technical schools were unknown and the schools preparatory for college could probably have been numbered upon the fingers. Youth were trained for college at home or by village masters or by the clergyman and lawyers of the community, their preparation depending upon the personal tastes or accomplishments of their preceptors. Having no common ideal or standard of preparation, the student retained much of his original personality.

It is a popular notion that in general learning, the student presented for admission to college today is superior to the students of any other period of the world's history, considering her or his age. This is doubtless so, at least as to mathematics and sciences, though they did have in the early part of the XIXth century individuals whose training in literature and art surpassed that of many people of today, and even in their youth.

The student should, however, distinguish between himself and his accomplishments. He should correct any feelings of superiority to his forefathers in intellect and mental capacity. If thrust into philosophical scales, he would be outweighed.

In the light of new things with which young people are surrounded, they, in their youthful enthusiasm, are likely to forget what the frequent perusal of biography and history would keep fresh with them, viz., a profound respect for the inventors and discoverers to whom we are so greatly indebted. Take Emerson's assurance that

> "No greater men are now than ever were. A singular equality may be observed between the great men of the first and of the last ages. . . The arts and inventions of each period are only its costume, and do not invigorate men. . . Galileo with an opera glass discovered a more splendid series of celestial phenomena than any one since. Columbus found the new world in an undecked boat. It is curious to see the periodical disuse and perishing of means and machinery. The great genius returns to essential man."

You should recall that the mathematicians Newton, Galileo, Leibnitz and LaPlace, and the scientists Boyle, Bernoulli, Lavoisier, Fahrenheit and Mongolfier, and the inventors Smeaton, Watt, Hargreaves, Newcomen, Roebuck and Wedgewood, all died in the XVIIIth century. The scholars of the XVIIIth century had great intellects and made great progress in scientific and industrial pursuits. They had the thermometer, the barometer, the microscope and telescope, the balloon, the hydraulic ram, the steam engine, the spinning-jenny

and carding-machine, and they made wonderful inventions in the industrial arts.

These men were not the product of schools. They were apprentices or private pupils of masters, who in mose cases made a profit out of the apprentices. Their early lives were spent in the shop or at the draughting board. They were specialists,—specialists from their youth,—but their general training and culture were neglected. So much for our student.

Second. Modern Educational Methods.—When the high school or seminary training is finished, several questions present themselves to a young person, among which are three, viz., (1) What shall I do or become? (2) Shall I attend school or become an apprentice? (3) Shall I enter the technical or general courses of instruction? The first question must be answered by the tastes, qualifications and opportunities possessed by the person. The second question is usually determined by the pecuniary limitation of the person. The third question depends upon the advantages to be secured or benefits to be derived, and is a subject for discussion under our topic.

It is not a new subject, but there may be some new things in it, in the light of another's experience. I am not an advocate of an extended general course in college as a condition precedent to technical training. The dead languages, history, philosophy and art, which may chiefly be characterized as polish, are not essential to either the professional or industrial. It is expensive and few can afford it. Misfortune sometimes cuts short the education of young men and they are required to abandon their studies and to seek their own living. Under such conditions the general student finds himself sorely handicapped in competition with the technical student. If you have had your experience in the field or shop or draughting-room, with your theoretical instruction, you have seen their application and utility While experimenting in physics, you have had your calculus, and while your mathematics were in mind you have been called upon to apply them to your engineering subjects. This is a great advantage. It not only cultivates an interest in the otherwise dry and abstract subjects, but it also assists the student in retaining what is taught.

Study is improved and the retention of subject matter insured by rivetting the attention of the student. This is done by requiring the student to write out his exercises or to take notes of lectures or to practically apply principles, or by conducting experiments, as designing, molding, erecting and creating the subject matter of study. It not only insures a better understanding of the subject, but it makes the student skillful in the useful arts. No abstract study can equal it in interest and delight, and nothing compares with the satisfaction that creation gives. The student becomes a wage-earner and his time is profitably employed.

I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self-reliance which the XXth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends he must gain

his experience and acquire a cliental. His married life is postponed and his ideal life shortened by a decade.

As to his success. I have observed that what he has gained in education he has frequently lost in courage, self-reliance and decision of character. He has not the confidence that accompanies the man who has struggled. He is past the age of youthful enthusiasm and spirit to do and dare. He has not the street-ruffian's power to endure and to rise from defeat. He contemplates doing much and looks for great success from extraordinary preparation, and when defeated is depressed and discouraged. Will it surprise you to be told that I can employ Harvard, Yale and Columbia University and law school and medical graduates with experience for $12 to $25 per week, for less than I can employ carpenters or brick masons, and good men at that? Because they have not patronage and cannot get it;—not from any fault of the men, but from the conditions that prevail.

If one has not the ambition and desire for further education after completing his technical education, it would be misplaced to force it upon him. An education in the schools might cease when the student is trained sufficiently to study understandingly. Edward Everett says,

> "Whoever has learned to read possesses the keys of Knowledge; and can, whenever he pleases, not only unlock the portals of her temple, but penetrate to the inmost halls and most sacred cabinets. A few dollars, the surplus of the earnings of the humblest industry, are sufficient to purchase the use of books which contain the elements of the whole circle of useful knowledge."

In the earlier days of education, theories and laws were assumed by one school, and controverted by others. These theories, designated as philosophies, were warmly supported and as violently attacked. Great strength of mind was exhibited and wonderful ingenuity displayed. Instead of starting with facts and results of experiment and investigation, and upon these facts establishing truths, theories and laws, they reversed the process. This frequently misled and deceived the authors and their disciples, and learned men spent much of their time tearing down and disproving the theories of others.

Fortunately, all this has been changed and modern methods of education are those where observation is cultivated and the reasoning faculties directed to explain the phenomena observed. This is the process of imparting information by directing the student in paths richly bordered with the fruits of wisdom, through regions graduated with natural phenomena and teeming with classified animal and vegetable creations. All things are named, compared and explained, and the student has to search for nothing. What he acquires comes to him without research or the exercise of much ingenuity.

This saves time, and enables the student to gather the most in the shortest time. The fields have been levelled, rolled and smoothed and cultivated to produce the hugest crops, in order that the favored son or daughter may make the greatest record at the harvesting. The field compares favorably with an ideal football field, tennis court or billiard table. The difficulties are removed. The student though in quest of exercise, has had everything done to lessen labor. Those obstacles that give to the forest trail its glories, or to the mountain stream its power, have been removed and the Venetian canal has been substituted.

"For what the College knows the youth must learn;
Not how to estimate or to discern
Things independently. Correct and slow
Bordered by banks of stone, direct and stern
As a canal, from centuries ago,
Its stream of thought flows on, as ever taught to flow."
—Alwyn: James C. Moffat.

What is the result? It is that all students have been to Venice; all have observed and been taught the same things. The original trend or natural taste of the child or youth has been limited to the banks of your canal. Your graduates are all alike. Genius has been dwarfed and freedom enslaved. Your shepherd poet and musician have become literary critics, and it is chiefly those who have rebelled at orthodox schools and whose genius has survived the mill, who have been our most progressive and greatest men. This is not a new thought.*

We need to cultivate more men like Wagner in music, Michael Angelo in art, Galileo and Newton in the sciences and mathematics, Tycho Brahe in astronomy, and Watt in mechanics. Heroes whose spirits no conventionalities could restrain and who overcame and turned the tide of the world's ignorance, prejudice and jealousies to the light and the truth. We need not go outside of our present day for examples. Our geniuses of originality live with us. We have our Roosevelt and our Witte present premier of Russia as representative statesmen; our Oyama and Togo as military heroes; our Kipling in poetry, James in letters and our Edison and Kelvin, our Sylvester and our Ramsey in the world of science? Does it occur to you that these men have been and may be today the subject of ridicule by their fellowmen? They have peculiarities and their uniforms, their weapons and their ideas are unlike those of the rank and file. They are originators. They have visions unlike the average man.

These limitations in education do not differ solely with the period, but they are greatly affected by the conditions and localities. They are less marked in the smaller and outlying schools than of those in our great communities. In this respect you are fortunate. Your fields and avenues are less artificial. You have by the bounty of great benefactors a field replete with opportunities and possibilities. You need not despair that it is not graded and paved with avenues and dug with canals, for the resourcefulness resulting from the exercise of your ingenuity will make you stronger and better. The youth who knows the pains of his labor and how much is its reward is the better for it. He will know how much he can depend upon himself and how little upon others.

Do not hope to find everything in great museums and laboratories. Your hills and valleys are museums of wealth untold and nature affords to you almost every phenomena of the laboratory. You have the fields around about, the heavens above you. You live in the midst of vegetable and animal kingdoms.

"The air is full of sounds, the sky of tokens; the ground is all memoranda and signatures, and every object covered over with hints which speak to the intelligent."

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*Read Cowper's "Tyrocenium" or Smiles' "Life and Labor".

In cities and the great universities located therein, the people have brick pavements, stone walls,—and under the roofs, in the underground avenues of transportation and in their vehicles, they forget that the sky overhead is not adamant or lignum. Their chief sources of knowledge are books.

Much profitable learning comes from primitive life and from the discomforts of human existence. A storm may mean much, I should imagine, to you here in Potsdam. It at least means overshoes and a storm coat. It brings discomfort. To your neighbors it means the stimulation of growing crops or perhaps the destruction of a harvest. A shower, a frost, a thaw, means something to some people. To one in the city it means so little as scarcely to be observed. We are under cover, or it takes but a step to find shelter. We pass from our roofs to closed public conveyances, to our offices, our shops or the stores. All are made comfortable, heated or cooled, lighted, ventilated and driven by electric or other power. It is indeed a millenium of human comfort and convenience, but it is not healthful to intellectual progress nor to physical development.

The dwellers in cities, from childhood, have witnessed the steam engine, the electric light, the varieties of motors employed in a hundred ways, the telephone, and the thousand of industrial phenomena about him, but very few know the first principles of their construction and operations. Millions of things are present and are devised to take the attention of the public.

In the general courses, the studies that you pursue are determined, in the larger universities, by the students' own election. The tendency is toward this plan. At Harvard you may elect your own subjects, and your graduation depends upon the number of points or hours gained or covered. Columbia has just announced the adoption of a similar plan; to break the "educational lock-step", as it has been characterized. By it the student may take his collegiate course and at the same time pursue studies required in the professional classes. This will lead to the three years' collegiate course and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect his profession or business, and to take subjects prescribed or acknowledged to be advantageous in the vocation adopted, then it is, to my mind, most desirable. If the student be permitted to follow his own inclinations, which in four cases out of five will be those avenues of least effort, then the system is detrimental. The student may know less at graduation than at entrance. If he elect the elementary subjects in the various departments, acquire what is popularly known as general culture, and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

To judge the real merit of an institution, one must have an experience in it. The examination papers are no criterion of the standard of scholarship, unless you know how the examinations are conducted and what per cent. is the pass mark. You will concede that a pass mark of 40 per cent. on a mathematical examination at which the student is given his notes and text books, or which he is permitted to take to his room for some weeks, is not to be compared with a requirement of 70 per cent. upon a paper submitted for a four-hour period, in which you must derive your own formula and during which

only clean paper and pencil are available or permitted. Yet this disparity has existed and I believe does exist between the methods and requirements of the greatest universities.

Students are able and inclined to avail themselves of their opportunities, but for undergraduates and technical work you need not envy the rank and file of the great universities for mental training, and after listening to your musical club and seeing your social environment you may well be content without the club life and city amusements that are so greatly overestimated by some business men.

These and the athletic organizations have become a prominent feature of the XXth century school. I do not regard them as essential features of an education. They are in theory beneficial, but in practice they are often otherwise. Unfortunately, they are not maintained for the development of those who need them most.

The societies, like the crews, ball teams and athletic teams, are not infrequently exclusive. They want youths who are highly connected, who came from families of culture and refinement, and who are not in need of the social training which the societies are supposed to furnish. A young man lacking in culture is not wanted and cannot secure admittance any more than the students who need physical development can make the teams or crew. Exhibitions of college athletic teams are no indication of the general health and strength of the student body, nor is the success of a few public men any proof of the superiority of the college itself.

There is the choice of schools to consider, the large and the small, those in cities and those in country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at a time. The various systems have many advocates. Each maintains that its system is THE system. There is the choice between the elective and the prescribed courses of study; the Berlitz and the classical systems of teaching modern languages; the experimental and the theoretical systems of teaching sciences.

In my opinion, it is those institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses, which prescribe courses for lower classmen and leave the election to upper classmen, that truly derive the benefits of both systems. In the heat of argument this does not suggest itself to the combatants. It is the onlooker who profits by utilizing both systems and who escapes the bad effects of the altercation.

To the student entering college, or leaving it to enter upon his professional work, I say,—Cultivate industry and earnestness. If you will excel, you must be in earnest. Shall I remind you with what you have to compete? If your taste be for music, I will introduce you to Mozart at six years, and Handel, Hadyn and Mendelssohn at fourteen, composing; Paganini at the violin and Hoffman at the piano, at eight; and Kubelik with his violin at twenty playing music composed for the masters. If for painting and modeling you should have known of Michael Angelo, who was eminent at 17 years, or Canova, who modeled a lion in the table butter at four and cut statuary at fourteen. If for poetry, you should read Schiller's epic poem, "Moses", written at fourteen years; Tasso, who at the age of ten composed a song in several parts, and when seventeen wrote his "Rinaldo"; or the poet

Chatterton, who died at thirty; or our Poe, who died at forty, after wasting a considerable part of his life so full of possibilities. If your taste be for mathematics, you should have read of Galileo, who discovered the isochronous oscillations of the pendulum at eighteen, Newton, who developed the binomial theorem at twenty; Zerah Colburn at six years solving abstruse problems and getting results by methods that perplexed the mathematical professors.

These are but a few examples in but a few branches of what you have to compete with. Biography affords thousands more.* I have not given you men of ages past; there are many of today.

Are you discouraged? You may well be, if it has been your hope to startle the world by your early attainments. But men have become great who were not precocious. Goldsmith, Swift, Paley, Dryden and Scott, who had every opportunity for schooling in youth, were declared to be "blockheads", yet in later life they became truly great. Their greatness is discovered in a later flowering, in an earnest application to retrieve the wasted hours of their youth.

Think as well as study. Reflect after reading or listening. Apply, compare what you acquire, reflect, consider, question even if you will.

> "Think! and let the thought not nerve you—
> Think of men who've gone before;
> Leaving lustrous names to serve you;
> Yours the path they've plodded o'er.
> Think! for thought's a wand of power—
> Power to make oppression shrink;
> Grasp ye, then, the precious dower!
> Poise it—wield it—work and think!"

Cultivate exquisite care and practice heroic effort. As our country grows older and competition becomes greater, the requirements of an education increase. Students who expect and hope to excel in the competition that prevails in our great cities must have something better or something different from that possessed by others.

The average student coming to college or to the technical school is very much like the grown-up person who seeks to perfect himself in some physical accomplishment. A child walks at the age of two years. Your mental training should be refined on the same plan. Put an exquisite finish upon your work. That is what makes the artist; it is what distinguishes the actor and soldier from the business man or laborer, and it is what makes the successful technician or engineer in the present day.

Cultivate observation of details. Take a pencil and draught a casing for a door, or the manner of laying the bricks in your sidewalk pavement, or draw the head of a cow and place the ears with respect to the horns. Note your observation of details. This may be cultivated by sports and games. Sail a boat and learn to take advantage of the currents and tides, the position and trim of your sails. Play chess and learn much that business requires you to practice. Cultivate music and its refinements.

Technical training as offered by our industrial schools tends to develop abnormally particular lines of the intellect and greatly en-

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*Read Samuel Smiles' "Life and Labor" and "Industrial Biographies."

larges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of the five senses. The world has need of specialists. He may not be wanted frequently, but occasionally his services are required when they command great prices. The employment of five persons, each representing the five senses, would attain vastly greater results than the employment of any one man with a normal development or education. You will recall Grimm's fairy story of "The Six Servants".

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree as the final goal of his educational ambitions. Few study or expect to study after graduation, except perhaps in short crams for a civil service or professional examination.

Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward, and at a rate that will appall you when you come into competition with some recent graduate fresh from his studies.

Systematic study ceases practically with the first twenty or twenty-five years of a man's age, whereas in the great schools of Rome, Greece and Egypt men were students till late in life. The conferences had then are scarcely known today. Men become teachers of youths. Time is now given by great educators in the discussion of methods of conducting primary and secondary schools. Our best musicians and artists make pilgrimages abroad and do earnest work under the instruction of masters, but it is the exception with our educators.

Third. Application and Utilization of an Education in the XXth Century.—A far-seeing man will, before spending very much time or money for a thing, inquire what specific uses he will make of it and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and sciences by his declaration that he doesn't like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work, it is a grave misfortune for one to school himself or herself in a business in which they have not a real liking and to which they cannot bring enthusiasm. Elect something to your liking and something in which there are opportunities and for which there is a demand.

What is there? There are thousands of things. There are opportunities as engineers to utilize the powers and natural products of nature; the energies of the wind, the streams, the tide and the sun itself are to be conserved. Our coal, oil and natural gas will soon be exhausted. The mineral wealth of every locality is to be mined or quarried, the vegetable growths are to be cultivated and developed, and animal industries are to be encouraged.

Great wealth is everywhere distributed by Mother Earth. She has been lavish in providing for her children. I said everywhere. Right here. You have under your feet and about you many such opportunities. You have the soil, the rocks, the minerals and the vegetation of the locality. How much is beneath, you know not. You

should know how much is going to waste about you; what forms of starch and cellulose are being allowed to decay and waste. How long has the paper industry been with you? To what uses shall we put these immense beds of silicon upon which this community rests? Shall we make a glass to outshine the Venetian product? Are there not slates, marbles,, limestones, in your Cambrian sub-strata? What have you done to utilize the heavy growths of your forests?

In the more industrial departments, what fields are open? Who will give us an alloy of steel that will not rust, or will rediscover the ancient art of tempering copper? Who of you will produce a light or power producing battery or dynamo, the waste products of which will be of more value commercially than the crude materials employed? What Tesla will gather the ever-present aerial and terrestrial electrical energy by the subtleties of his art and without laborious machinery and continual expenditure for coal, and what Marconi will command the waves of light, heat, sound and of the sea even, without bridal or rein?

In the industries the metals in a solid state are rolled, forged and squeezed into every conceivable shape. Perfect steel ball bearings, steel tools, steel double-reversed milled-headed screws and steel projectiles, are produced in a perfect state with the simple thrust of two opposing forms and are turned out as fast as the machine may be fed. Intricate gear wheels are moulded under enormous pressure and so perfect as to defy flaws, roughness or imperfections. Such competition cannot be met except by the same or similar methods, and foreign manufacturers and economists may well come to America to study not only our methods but our schools, where the geniuses of these inventions are trained and educated.

For engineers there are cities to be built, public improvements to be created, waterworks, sewers and extractor or utilization plants of public wastes, and power and sewage plants. Do you know that all the garbage, cinders, ashes, street sweepings and some of the sewage of the great city of New York are utilized and of profit to the City? Here are fields for the ingenuity of trained young men and they are sources of great revenue. The City of New York is now completing a lighting plant, the fuel for which was heretofore wasted.

If a municipality can utilize the waste of the households which contribute the city's garbage, what may not be accomplished in the household itself? It is said that one-third of the food of American households is wasted. It is well known that foreigners live much more economically.

There is indeed a great field for your home economics. I am much interested in that department of your school. It should be well patronized and there should be a good demand for its graduates. It is becoming a subject of much interest in the schools of our great cities, where housework is despised and where the American home, the cradle of patriotism and good morals, is threatened to be supplanted by the fashionable boarding house or hotel.

Naval architecture and marine engineering seem to present a promising field, as does also the design and manufacture of motor cars and wagons. Chemical engineering affords great opportunities, especially in the industrial arts. No occupation offers deeper or more subtle research. The discovery of a substitute chemical or a change in the process of manufacture frequently revolutionizes the price of

the product. The prices of sugar, soda, starch, steel and aluminum and a thousand other commodities are examples. The production of the many coal-tar products as substitutes for natural organic substances is an industry little known in this country. The manufacture of saccharine for sugar, artificial flavoring extracts for fruit syrups, of the coal-tar dyes, perfumes, drugs and chemicals, have all to be extended and perfected. In this field of chemical research we are behind our European contemporaries.

Architecture presents an attractive occupation to a student who combines artistic tastes with constructive ability. The remuneration is sufficient and the position in the community that of a professional man.

What is the new science of "plasmology" to reveal? Are we at the dividing line of life and death, and is it universal life or universal death? Is a crystal but an entombed cell? These are absorbing subjects for the XXth Century to struggle with.

What mysteries may yet be unfolded in metaphysics and psychology? What new senses and dimensions will be disclosed? What combinations of physical and chemical science under the searchlight of mathematics will disclose the fourth and higher dimensions?

Man, though limited by his physical senses to three dimensions, finds that his mathematical reasoning applies as well to four, five and more dimensions. What has the XXth Century to enlighten these truths? What XXth century genius will do for us what Maxwell did for the XIXth era?

If Roentgen Rays, and Hertzian waves, why not a multitude of other possibilities revealed by natural phenomena not distinguished by the five senses, but rendered comprehensible by auxiliary agencies within human control?

What new discoveries await the combination of occult phenomena with what is known? With the better understanding of vibratory phenomena and its laws, what new and wonderful discoveries await us? What mysteries are to be unfolded in all the range of undulatory phenomena between sound and heat, and between heat and light and electricity, and by what artificial means are we to bring them within the purview of our few and limited physical senses? Shall we enter the sphere of other animal creations and the phenomena which their senses enable them to comprehend?

Who shall first discover celestial life, and who first establish interplanetary communication? What modern Donnelly will bring forth new theories of lost Aryan races and attempt the explanation of the world's legends and religions?

What discoveries are to be made of submerged continents, and what conditions of man are to be revealed that antedate history or human knowledge? What surveys of submerged continents at ocean depths are rendered possible by submarine navigation? What upheavals may the century afford and what may it not disclose? Have we availed ourselves of all that Mont Pelee and St. Pierre furnished in explanation of Pompeii and Herculaneum?

Shall we struggle with Aerial Navigation? Will its solution be found in some means of neutralizing or negativing gravitation? Is the action of gravity perfectly understood any more than magnetism or chemical affinity? Who will separate the known elements into ultimate primary substances, the positive and the negative, and finally explain the elementary qualities or matter?

The utilization of technical training in the industrial pursuits and development is everywhere apparent in this country. To no other one element are the country and the people more indebted for their wealth and prosperity. The physical comforts of home, of business and of travel are due to the marvellous provision of the technician. By his wonderful inventions man hears, talks and writes without regard to distance; he enjoys the fruits and products of every part of the globe, and makes world circuits in the time required for some of the planets. His thoughts are conveyed as the will of his Creator through intervening space; his favorite views are registered in light and shade and his pleasing melodies in undulations of sound, his records in enduring bronze.

The economic value of this training is illustrated by the trade, domestic as well as foreign. While continental Europe is paralyzed with trade depression and demoralized with competition, our United States is greatly profiting in her trade with all countries and not less in her interstate commerce. Witness also the power and strength of the Nation in war as well as peace. Neither Spain, Russia, Italy nor any other country, can have claims to world power until they develop the industrial talents of their people and the natural resources of their land. The balance of power remains where the industrial and mechanical are best treated. As Carlyle said many years ago: "The true epic of our times is not Arms and the Man, but Tools and the Man—an infinite wider kind of epic".

Education of this century should not be confined to book learning nor to the study of mathematical and physical laws. Some time should be given to economics and sociology. Methods and means of conserving and protecting what is acquired are quite as important as are the ways, methods and means of acquiring. Close upon the footsteps of progress in its march is trade, with its competition and its protector, economy. The wasteful methods of the pioneer can not survive the rivalry of commerce. Economy in the production and utilization of materials or power is what effects great savings, and it is the man who can effect great savings who can command a salary commensurate with his savings. Today the waste of gold mines of the XIXth century is being reduced at a good profit; the great waste culm piles of the anthracite coal fields furnish perhaps one-fourth of the fuel of the middle states, and the wastes of many manufactories that were a source of expense and annoyance have been turned to profitable uses.

But the XXth. century education should not only cultivate the courage and capacity of a man or woman to cope with nature, but should also give some insight into the laws, institutions and systems of society. Young men or women should have some understanding of what is before them and what to expect of their fellow men and women. It frequently takes some people the best years of their life to become acquainted with themselves and to discover what they really are to the world. Some men take years to overcome the natural diffidence and timidity that possess them, which might be corrected in youth by proper surroundings and by a kindly interest of their teachers. The finest pearls are often found in the most obscure places.

I believe that one-half of the dull boys and girls of our schools have become so from mismanagement. The boy who becomes stub-

born and vindictive, and who seems to lack reasoning powers, is too frequently the product of the cramming and forcing process applicable to domestic animals, resulting in a sullen don't-care disposition, which if not conquered either by love or a firm discipline destroys the youth's future. Young people are not often mentally deficient, but more often careless and willfully indolent. They should be helped and even if it be a thankless job. The teacher's reward is in the great hereafter,—brought nearer we trust by Mr. Carnegie's millions for pensions. Even though your efforts be met with indifference and inappreciation, yet

> Laborious still, he taught the early mind,
> And urg'd to manners meek and thoughts refin'd;
> Truth he impress'd, and every virtue prais'd;
> While infant eyes in wondering circles gazed;
> The worth of time would day by day unfold,
> And tell them every hour was made of gold.
>
> —Timothy Dwight.

Courage and confidence every young person needs. Every person should be counselled in what things he may find himself wanting and how to strengthen himself. And not the youth alone,—some of us longer in the world often want encouragement.

A discussion of technical education in this century should not omit some reflection upon the social inequalities that are certain to exist. We may look back upon a century mighty in its achievements, gigantic in its forward stride, matchless in its intellectual expansion, industry and invention, in its manifoldness and the vastness of its enterprises, the grandest of all the centuries in history. The heavy burden of labor has been taken from the shoulders of men, and the workman has been made the equal of his neighbor. He has better food, raiment and shelter and better remuneration for his time. The lowly have been raised to positions of comfort, and the industrial world has provided for them at a mere moiety of what it cost them to live a few decades ago. Those who work and are engaged in industrial occupations do not suffer from want and distress, but it is the downtrodden and ignorant people who have come to our shores from foreign countries and who have not become a part of our industrial army.

For the great stream of the lower classes which is making its way to our shores, something must be done. Every one of them should be contributing to the advancement and industrial progress of our country. They are parasites upon the legitimate business and other interests. The technical schools should aim to turn out men who can undertake the instruction and improvement of this class of people. Trade schools should be erected and instruction offered them in the useful arts.

The power of the technician and his ability to utilize the great forces of nature make him a threatening element in the scale of sociology and one to be dreaded if not safe-guarded. The recent events in Russia show how helpless is a nation in the hands of any branch of the industrial element. Stop the wheels of the manufacturing and transportation facilities of a country, and the nation is crippled and its people starved. They control the great avenues of commerce, the necessities of life,—food, fuel and raiment. Never was there the ne-

cessity for the unity of men and the realization of the dependence of the polite upon the industrial.

The education of the XXth. century will, I predict, enlighten every continent on the globe. What has been begun in the past century will lead to greater and more lasting results in this cntury. The XXth century should lead the human race to heights which shall strengthen the faltering steps of art, philosophy and religion.

What the XXth. century demands, is the cultivation of originality and the development of the creative genius of students. Creation should be the highest aim of every student. A small thing created may be truly greater than a large thing borrowed, and the original thought or design of vastly greater import than any imitation. The Japanese are said to be great copyists and they may reach a state of civilization equal to that of the XIXth century in a short period, and for such a nation it may be the best policy that can be adopted to overtake the western nations, but it alone is not likely to create a nation of inventive workmen or geniuses, nor is it likely that it will enable our oriental friends to surpass or even overtake the Saxon race. The present century requires the development of geniuses and especially in the technical fields. Old and trodden fields must be departed from and new, though rough, trails taken. New practices and methods must be devised and these are more likely to be discovered by departure from, than by following in, the channels hewn by our predecessors.

Entertain new ideas, and not only be a recipient but endeavor to be a giver of new things. In your daily tasks try to present new and well-considered facts and ideas and learn how few really new things you will conceive. Someone has said, "There is nothing new", and our new discoveries they undertake to show were known to the ancients. I remember as a boy hearing Wendell Phillips deliver his lecture upon the lost arts. I was then in high school and it was my earliest realization that we were not altogether "It". In the mechanical world, if you wish to learn how little is unknown, send your best inventions to the patent office and discover how many have already applied for the same thing. If you aspire to literature write a couplet or stanza and send it to the press, and see how quickly the thought will be pointed out as that of another. If you aspire to become a lecturer and to deliver an address to some technical school, sit down and prepare at considerable length your lecture, say upon "The XXth Century Education", and then receive considerately the addresses of several of your predecessors, and find your own ideas and thoughts as well expressed that there is nothing for you to say. You will then experience what I did, but with no such happy explanation as befell a noted divine who, having spent great labor in the preparation of his sermon, met at a gathering after its delivery the distinguished author, Mark Twain. Mr. Twain, after congratulating the reverend gentleman upon the success of his address, informed him that he had a book at home which contained every word of his sermon. "Indeed", said the clergyman, "what may be the name of this remarkable book? I assure you that the sermon was my own." The joker replied, "Oh, it is in my dictionary."

In conclusion I give you a parting thought to cherish as a secret of the success of many business men. Have faith, be optimistic and of good cheer. Be not pessimistic or agnostic. It betrays dissatis-

faction, an unhappy disposition and one not to be cultivated or prized by others. William Tell may have been a popular hero in the XIVth century, but his disciples would not make successful business men today. Moreover few of us could perform William Tell feats of bravery and skill. "Laugh and the world laughs with you; weep and you weep alone".

A good asset in business and which sometimes outweighs accomplishments is good fellowship. Have faith, and with it patience. I will give you an instance in my own life. In 1883 I was in Chicago in the employ of some wealthy men as an engineer in the design of cars, trucks and shops, when I was called in to check the disbursement of a considerable fund that had been raised to demonstrate the practicability of certain alleged discoveries in electrical phenomena made by an erratic genius. I was not merely to check the disbursement of moneys but to act as a check upon what were termed crazy ideas and swindling projects. This man had declared that he would revolutionize the methods of generating electricity. He appeared to ignore all the accepted laws of coils cutting lines of force and built up large disc wheels of circular plates, claiming that they needed no commutators. All this was insanity to the profession, but I wrote to my college professor of physics describing it in some detail, and he counselled patience. We were patient until we had spent some $14,000, when the capitalists and the inventor became distrustful of each other and separated. Shortly after Nicola Tesla announced his polyphase induction generator, and distrust and pessimism had doubtless deprived our inventor of the fame to which he had aspired, and deprived the capitalists of the great gain and profit that a monopoly of the alternating system of generators would have secured. The memory of this experience I have carried with me, and with it these lines of John Hopkins:

> "Believe in the new age, in the better day. Be hospitable to new thoughts, to new truths. Be alert to use scientific methods and quick to utilize the best gifts to civilization. Be tewentieth century men. Believe in liberty. Trust your fellow-man."

The XXth century education should embody artistic treatment in structural work and in mechanical contrivance,—a relaxation from the intensely practical and economical to a study of what is pleasing and what is beautiful. Some have an idea that there is not much that is beautiful in the mechanical and industrial. Nothing is further from the truth. Mechanical structure and contrivances that have the greatest strength with the least material are copies of natural forms. Smeaton's Eddystone Light House was designed from the bole of a tree; our most beautiful designs in laces and tapestries are from the frosting of our window panes and from Chladin's vibrating plates sprinkled with sand; our suspension bridges are mammoth spider weavings and our structural shapes and forms are largely those of the vegetable kingdom modified to meet the requirements of economical manufacture. The poets have found fruitful fields in our industrial world. Burns, Darwin, Emerson, Holmes, Kipling, Lowell, Mackay, drew their inspiration largely from the industrial life and farms, and no poems have been more popular in the English and German languages than Longfellow's Village Blacksmith, his Building of the Ship and Shiller's Song of the Bell. In painting and sculpture much less has been done, but some of the most cherished are those of industrial

life. The Angelus, the Reapers, the Mowers, of the older school and the Crowning of the Blacksmith are among our paintings the most prized, and the earliest statuary was of husbandry and the useful arts. Recent statuary of steam, of electricity, of power and of labor, have been received with great favor.

It is for the XXth century education to impart the beautiful and artistic to the useful, to lend inspiration and give expression to the deeper feelings of industrial life, its burdens, its struggles, its rewards and its glorious victories. The XXth century should make its technically educated men something more than mechanicians, something more than the mere directors of processes. Men and women should be taught to vary their employment and to seek recreation in the profitable exercise of their intellectual faculties. The spirit of man needs more than gain, more than crowning success of its efforts, more than the applause of fellow men; it needs the hope and cheer of the life everlasting; it needs faith in eternal life and the resurrection and the reunion of those most dear and beloved; it needs the sympathy, love and encouragement of fellowmen in times of distress and despair.

One's physical wants and his ambition to excel should never deprive him of soul culture, and however imperative routine duties become, they should never be allowed to deprive the heart of its solace.

> Sum up at night what thou hast done by day;
> And in the morning what thou hast to do;
> Dress and undress thy soul, mark the decay
> And growth of it; if with thy watch that too
> Be down, then wind up both. —Herbert.

This evening's exercises fitly commemorate the Founding of this School of Technology; they commemorate a great event; great in the history of our educational institutions; greater comparatively to this community, but none the less great as contributing to the world's good and betterment. It marks the realization of the wish of three sisters to confer upon future generations the blessings of a useful training and a practical education, and the desire to perpetuate the memory of a beloved brother. It marks an act that demonstrates the wonderful foresight that belongs to few, the unselfishness of the great heart and that faith in the mankind and the future which characterizes the true christian spirit. These are what make our true philanthropists. It should be a blessing to the founders of this institution that they may see and know the great good that has resulted from their benevolence, during the first ten years of its history now closing.

> "There is no other greatness; to make some nook of God's creation a little more fruitful, better, more worthy of God; to make some human hearts a little wiser, more manful, happier, more blessed, less accursed. The first and paramount aim of religion is not to prepare for another world, but to make the best of this world; or, more correctly stated, to make this world better, wiser and happier."

This is the greatest and best use, the highest and noblest object of wealth.

It is my supreme happiness to be with you and to be one of you upon such an occasion as this, the Anniversary of Founders Day, which brings home to you the aim and purpose of this educational endowment, that of the Thomas S. Clarkson Memorial School of Technology.

FOUNDER'S DAY EXERCISES, 1905.

Founder's Day exercises were held in Clarkson Hall, at eight o'clock in the evening, Thursday, November 30, 1905. The musical programme was rendered by the Welker Orchestra, under the leadership of Mr. Loy E. Welker, '09, and the vocal quartette, under the direction of Miss Claire L. Mann. At the opening of the exercises, Rev. D. B. Patterson, Rector of St. Phillip's Church, Norwood, N. Y., read a Scriptural selection from Job XXVIII: 1-12; 23-28, and offered the following prayer:

"Almighty and most merciful Father; the Creator and Preserver of all good, we thank Thee that Thou art always bringing great things out of little.

Thou dost form the seed and see that it is planted; Thou dost bring the darkness, the dew and the light; and out from these forces Thou bringest unexpected blessings.

We thank Thee that into loving hearts Thou didst put the thought of the Thomas S. Clarkson Memorial School of Technology for the advancement of science, promotion of learning and dignifying of labor.

May the forces that make for growth continue to the enlargement of this blessed work. Bring life from everywhere, as Thou dost for the growing plant, to this ever deepening and spreading work of Thine.

So continue with this School that all connected with it may feel that they are under Thy protection and guidance.

Follow those who go from its doors so well fitted for the action of the awakening world. And wherever they go may they carry something of the spirit that gave them the Thomas S. Clarkson Memorial School of Technology, to the glory of Thy Son, our Lord. Amen."

PROGRAM.

Overture—From "Martha,"........................Flotow

Orchestra.

Song of the Vikings—Arr. from Fanning, by Irving Emerson

Vocal Quartette.

Scripture Reading and Prayer,

Rev. D. B. Patterson.

Intermezzo—From "Cavalleria Rusticana,"...........Mascagni

Orchestra.

Address—"Technical Education of the Twentieth Century,"

John Cassan Wait, M.C.E. (Cornell), LL.B. (Harvard)...

"Moonlight Serenade"............................Moret

Orchestra.

"The Heaven and the Earth Display,"

Arr. from Mendelssohn's Athalie, by G. A. Veagie, Jr.

Vocal Quartette.

Benediction.

BELT TRANSMISSION OF POWER AS AN ANALOGUE OF ELECTRIC TRANSMISSION.*

BY BYRON B. BRACKETT, A.M., PH.D.**

The flow of water through a pipe is often used to illustrate an electric current and its properties. But if it is desirable to use analogies at all in studying the various phenomena connected with currents of electricity, the simple machine belt or rope drive will serve the purpose quite as well as water forced through a closed pipe system. No further modification or variation from the usual conditions of operation will be required, in the case of the belt drive, than it is necessary to make or assume in the common hydraulic analogy.

Imagine for a moment, an endless belt passing as a wrapping connector in the regular way around two pulleys, or wheels, one driving, the other driven. The tension in this belt at any point may be assumed, for illustration, to represent an e.m.f. The speed of the belt will then represent, by analogy, the electric current itself, The tension multiplied by the speed of the belt gives, with due respect to the units of measurement, the energy transmitted in the unit of time represented by the speed, just as e.m.f. multiplied by current gives the electric energy, with similar respect to the units involved and the time considered.

To illustrate the effects of resistance and resistance losses in the electric circuit we must assume the somewhat unusual conditions of a driving belt operating in a perfectly viscous fluid, where the pull necessary to keep the belt moving through the fluid increases in direct proportion to the speed of the belt. This is not so exceptional a condition, nor so difficult to attain, experimentally, as the modification of actual resistance to the flow of liquids through pipes, which of course must be made in order to fit the hydraulic analogies to the phenomena they are supposed to illustrate.

The force required to pull the belt through such a viscous liquid as we have assumed would represent the portion of the tension lost, or rendered useless, before reaching the driven wheel. Thus it represents quite satisfactorily the e.m.f. lost in the transmitting lines. This assumption makes the numerical value of the resistance to be the tension required simply to keep the belt moving at unit speed or velocity. Hence to move the belt at unit velocity in a medium offering a resistance greater than unity will require a tension equal to that resistance, while to maintain a velocity other than unity would require a tension equal to the product of the belt's velocity and the resistance. Such a product will equal that part of the whole tension which is needed to maintain the motion of the belt in any portion of its complete circuit or the total tension required, according to whether the resistance used as a factor in the product is that opposing the movement of the belt at a portion of its path only, or along its entire path. All this will be seen to be in accord with the relations of Ohm's law.

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*Abstract of article in Electrical World and Engineer, xlvii 986; Dec. 9, 1905.

**Professor of Physics and Electrical Engineering, Thomas S. Clarkson Memorial School of Technology.

As stated by Ohm himself the law reads: "The strength of the current varies directly as the e.m.f., and inversely as the resistance of the circuit." But when applied to a portion of the whole circuit only, as, for example, to the transmitting line without including the motors, lamps or other receiving apparatus, the same relation may be more conveniently expressed, thus: the e.m.f. (needed for the portion of the circuit considered) varies directly as the product of the current and the resistance (of the part of the circuit under consideration).

It is further evident that the power consumed along the belt between the driving and driven wheels, would be proportional to the square of the velocity of the belt, illustrating, in this case, Joule's law.

According to this law, the heat developed in an electrical conductor, during any definite interval of time, is proportional to the square of the current and to the resistance of the conductor. Since the belt we are considering moves faster and pulls harder, at higher velocities, it illustrates most perfectly a conversion of another form of energy, into heat energy at a rate proportional to the square of the belt's velocity, which is analogous to the electric current.

To grip this belt at any point of its motion and hold it in a position of rest would be similar to opening an electric current. The effect of the action, in either case, would be like inserting an infinite resistance at that point. When the belt is so held the driving wheel produces the full tension on the belt, at its point of application (or contact with the driving wheel), without causing any movement of the belt, just as the open-circuited dynamo develops an e.m.f. without delivering any current.

Starting and stopping conditions may now be considered. If the belt is without mass, or as is often said, without weight, its movements at once respond to the tensions produced at and by the driving wheel. The speed instantly reaches such a value that the resistance (the resisting forces) exactly equals the moving tension.

If the belt has any perceptible mass some of the moving or driving tension will be required to overcome the belt's inertia, as long as any change of speed is in evidence. Hence, a heavy belt would start slowly. It would keep or maintain itself in motion more persistently so to say, when once set moving. This phenomenon represents the behavior of the so-called electric current in a circuit having self-induction. Since self-induction is a property not of the current but of the circuit, one might infer that it should not be represented by any analogous property of the belt, since that or its velocity has been assumed to represent the electric current. It may be recalled that such an inconsistency is committed by those who use hydraulic analogies; and, further, if one wishes, he may imagine the belt, which we are considering, to set into rotation any number of flywheels in the space about the belt by simply running over them. There may be many of them, and each one assumed to possess small inertia, to represent distributed self-induction; or, large and definitely located, to represent an inductance coil or some similar apparatus.

Moreover, if desired, one may find in the mass, radius of gyration, etc., of these inertia wheels, analogies for the magnetic flux, convolutions, etc., of an inductance coil. But it is not our purpose to examine these in detail. If there is mass inertia, directly connected with the changes in the speed of the belt in question, whether derived from the mass of the belt itself, or, from masses that are moved when-

ever the belt moves, there may be observed in either case phenomena analogous to those connected with a circuit having self-induction.

Should we attempt suddenly to stop such a belt as we have just considered, serious damage might result to the mechanism. The belt may break loose from the grip or other device which was introduced to stop it, and thence continue in motion for a time. This may ensue in spite of the efforts to check it, just as the electric current in a circuit with large self-inductance arcs across the switch, and maintains the so-called flow for an interval that is more or less brief, depending upon the circumstances. Again, the momentum of the belt in such a condition might actually wreck some portion of the mechanism from the stresses caused by an attempt quickly to bring it to rest, just as an effort to stop, in too short a time, the electric current in a circuit with self-inductance may result in a puncture of the insulation of the conductor.

In fact, the actual equations that apply to the building up or dying down of the electric current in a circuit with self-induction, apply without change to starting or stopping a heavy belt. In which case, also, the mass or mass equivalent of the belt, and of all masses moved by it, take the place of the inductance of the electric circuit. The velocity of the belt is used for current strength, and the driving tension is the belt represents the applied e.m.f.

This may be proved as follows:

Let T = tension in the belt.
R = frictional resistance to movement of the belt, as previously explained.
S = velocity of the belt.
a = acceleration of the belt.
m = mass equivalent of the belt.
t = time from application of T.

Then, at any instant, we have

$$T - S\,R = a\,m = \frac{d\,S}{d\,t}\,m,$$

or

$$d\,t = \frac{d\,S}{T - S\,R}\,m,$$

which may be written in the form

$$d\,t = -\frac{m}{R}\left(-\frac{R\,d\,S}{T - S\,R}\right)$$

Integrating between the limits $t = 0$ and t', and $S = 0$ and S', we have

$$t' = -\frac{m}{R}\left[\log\,(T - S'R) - \log\,T\right],$$

or

$$-\frac{R\,t'}{m} = \log\left(\frac{T - S'R}{T}\right)$$

hence,

$$\epsilon^{-\frac{Rt'}{m}} = \frac{T - S'R}{T},$$

and finally $$S' = \frac{T}{R} - \frac{T}{R}\epsilon^{-\frac{Rt'}{m}} = \frac{T}{R}\left(1 - \epsilon^{-\frac{Rt'}{m}}\right)$$

Thus, the velocity or speed of the belt, at any instant t' after a constant driving force, T, has been applied, is found by a formula which is identical with that for the electric current at a time t' after a constant e.m.f., E, has been impressed. The correspondence of the other quantities involved has already been noted.

The term $\epsilon^{-\frac{Rt'}{m}}$ in parenthesis in the above expression, becoming negligible when t' has a large value, the ultimate speed of the belt becomes constant at a value equal to T/R; and the time required for any fraction of this ultimate speed to be attained, will depend upon m/R, which is the *time constant* of the system.

By a like method, the stopping conditions, after the driving tension has been removed, may be shown to be given by the question:

$$S' = \frac{T}{R}\epsilon^{-\frac{Rt'}{m}}$$

This may be considered in every sense analogous to the decay of the current value in an electric circuit with self-induction, after the impressed e.m.f. ceases to act.

We may now suppose the belt to be elastic so as to stretch when any tension is applied to it, till the elastic forces are sufficient to cause a steady movement of all parts of the belt; or, better still, we may imagine to exist between the surface of the belt and the medium or mechanism surrounding it, an elastic connection such that to establish any given speed of the belt a definite amount of stretching must occur, and remain operative so long as the same conditions of speed continue. In either case the initial speed of the belt at the driving wheel, resulting from the application of any constant driving tension, will be larger than would exist, if all other things were the same, and the belt with all of its connections had no elasticity. But, when the belt has been sufficiently stretched all phenomena will go on, while the driving tension remains constant, as if there were no elasticity to any part of the mechanism under consideration. When, however, the driving tension is removed, this elastic stretch will tend to move the belt backwards, for an instant. This is in all respects similar to starting an electric current in a circuit having capacity. For, when a constant e.m.f. is applied to such a circuit, there is a temporary rush of current into the circuit, larger than would flow over the same circuit if it had no capacity, or larger than the ultimate value of the current which is determined by Ohm's law. Again, when the e.m.f. is removed and the circuit kept closed there is a temporary back current which soon dies out.

To express the extra speed of the belt mathematically, we must consider a belt with unit elasticity to be one which will stretch a unit distance under a tension of unit value. Hence, one which stretches n units under unit tension will have an elasticity of n. Such a belt, if held firmly at the driven wheel, would move at the driving wheel, under the influence of a moving tension T, a distance, $D = Tn$, or $T = D/n$. These represent the ultimate conditions or those when rest ensues.

In general, after a definite interval of time, before the conditions of rest have been reached, a portion of the total tension (applied to the belt at the driving wheel) would be balanced by the elastic forces from the stretch already attained; and the remainder would be consumed in moving the belt against friction at the velocity then existing. Represent the tension required to balance the elastic force by T_1, corresponding to a stretch D_1. Then, $T_1 = D_1/n$. The other portion of the force will be equal to $R\,S'$.

Hence
$$T = R\,S' + \frac{D_1}{n}$$

or
$$Tn = R\,n\,S' + D_1.$$

But
$$D_1 = \int S'\,d\,t$$

or
$$Tn = R\,n\,S' + \int S'\,d\,t.$$

And differentiating, we obtain:

$$o = R\,n\,d\,S' + S'\,d\,t,$$

$$d\,t = -Rn\frac{d\,S'}{S''}.$$

Integrating this between the limits of o and t'; S_0 and S', we have

$$t = -Rn\left(\log S' - \log\frac{T}{R}\right)$$

since S_0 must be equal to T/R, all of T at that instant being available against frictional resistances. Solving the above for S' we now obtain

$$S' = \frac{T}{R}\epsilon^{-\frac{t}{Rn}}$$

This is entirely similar to the case of an electric circuit with a condenser inserted directly in series with it. The condenser puts in an infinite resistance at one point, but gives an effect of elasticity to the circuit.

We might consider the stopping conditions, and develop their formula when the belt is held, as above. Or we might develop the more important relations that apply when the belt is not held stationary at one point. This would be analogous to a closed electric circuit with capacity between different parts of the circuit. Here there is the current value which would exist without capacity, and, an additional current, at the start, obeying the laws above explained.

It is not necessary to multiply details. All of the interesting relations may be developed through using the analogy of the belt drive. Mechanical elasticity, in the sense that we have defined it above, is more nearly a perfect analogy of electric capacity than is shown in almost all illustrations used. It must be here remembered, however, as in the case of self-induction, that capacity is distinctly a property of the circuit itself and not of the current. If any one should think that elasticity of the belt is not a proper analogy let him bear in mind that the elasticity may be applied to the regions near the belt and in contact with it, without making any changes in the relations which we have considered.

For the purpose of establishing a comparison with the possible operation of the belt transmission, the alternating current of electricity may, for the moment, be conceived of as starting and stopping continuously, first in one direction and then in the other. Now, if we rock the driving wheel back and forth, so to speak, the motion of the belt may be treated as an analogue of the alternating current. It is self-evident that any considerable inertia, or elasticity of the belt, would affect its motion, under such conditions, much more than when driven in one direction. Inertia and elasticity, as already defined, will modify the velocity of such a driving belt, moved first in one direction and then the other, in exactly the same way and to the same extent that self-induction and capacity are known to modify the alternating electric current. Moreover, formulae showing these relations may be developed from the properties of the mechanism of the belt transmission; that is, the behavior or phenomena of the ether medium as affected by the transmission of an alternating current of electricity, may be illustrated by the well-known properties of ordinary matter.

A REVOLVING SUPPORT FOR THE HEMPEL GAS PIPETTE AND LUNGE BURETTE.

By F. M. Williams, A.M.*

In making a gas analysis with the ordinary Hempel pipettes it is necessary to raise these upon a suitable support to a convenient height for attachment to the gas burette. This is ordinarily done by placing the pipette upon some sort of a stool or block.

The accompanying sketch shows a very convenient form of support, consisting of an upright standard upon which are revolving arms radiating from a loose collar which is adjusted to proper height by another collar having a set screw. To these arms a number of pipettes may be attached by small hooks. The upright standard also affords a support for clamps which hold in position the burette, preferably of the Lunge pattern. The height of the revolving arms is so adjusted that the various absorption pipettes may be swung into position for attachment to the measuring burette.

The base of the standard is screwed securely to the table, but should it be desired to have the apparatus portable, this could easily be done by making the cast iron base somewhat larger.

In addition to the advantages of great convenience and rapidity of manipulation, the absorption pipette and contents may be agitated by swinging upon the arms without strain upon the glass portions of the apparatus.

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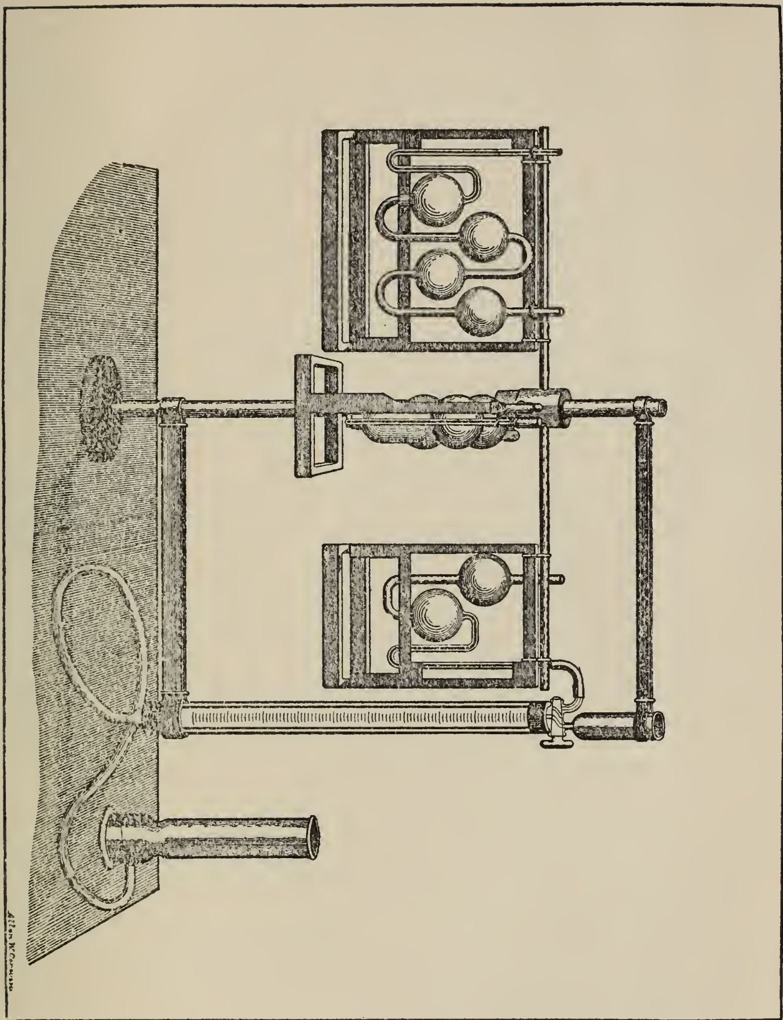
*Professor of Chemistry, Thomas S. Clarkson Memorial School of Technology.



ECONOMICS OF MANUFACTURES.

By Walter S. Graffam, B.S.*

Economics 6. This course is given to the junior class of engineering students, one period, weekly, during the second semester. It comprises a study of modern methods of workshop production, from the design to the finished product; details of standardization, duplication and interchangeability of machine elements; shop accounting, systems and organization for economic production and distribution.

Syllabus.

Part I. Organization and Management.

1. Board of directors or of control.
2. Administrative officers, president and manager.
3. Executive officers and superintendent.
4. Departments and internal organization.
5. Department officers, foremen and assistants.
6. Workmen and their grading.
7. Classified and miscellaneous help.

Part II. Development of Manufacturing Industries.

1. Location of industry, factors determining.
2. Arrangement of plant and buildings.
3. Arrangement of facilities.

Part III. Employment and Wages.

1. Systems of employment.
2. Employer and relations to employees.
3. Employees and relations to employer.
4. Wages and basis of remuneration.

Part IV. Methods and Processes of Manufacturing.

1. Modern methods of workshop production.
2. Efficiency of productive processes.
3. Tools and machinery.
4. Inspection of materials, work and plant.

Part V. Science and Invention in the Workshop.

1. Place of experiment, tests and research in the shop.
2. Systems of aid and encouragement of improvements.
3. Inventions and discoveries of employees.
4. Patents and employees.

Part VI. Economics of Workshop Production.

1. Costs, charges and distribution.
2. Estimates for proposed work.
3. Replacement and scrapping machinery.
4. Shop accounts and accounting.
5. Stock accounts and inventory.
6. Waste, bye-products and disposition.

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*Superintendent of Shops, Thomas S. Clarkson Memorial School of Technology.

NEW COURSES OF INSTRUCTION, 1905-1906.
II. SEMESTER.

Electrical Engineering, E.E. 32. Junior Electrical Design. A special course, elective for juniors, in the design of direct current machinery. Prerequisite, E.E. 1-2. II.; arrange time; (1). Professor Brackett.

Drawing 32. Advanced Mechanical Drawing. Isometric and other methods of projection than the orthographic; linear perspective; shades and shadows; applications in engineering and building construction, structural and architectural work, conventional details and symbols; color work. II.; arrange time; (2). Professor Willhofft.

Mechanical Engineering, M.E. 21. Advanced Testing Materials. Special mechanical and physical tests of bronzes, alloys and anti-friction metals, including micrographic examinations and study of structure; methods of steel reinforcement of structural concrete work; road materials and properties, and comparative tests for valuation and efficiency; assignment of individual problems and projects for investigation, tests, and reports. Prerequisite, M.E. 20, Mechanics 2. II; arrange time; (1). Professor Willhofft.

Mechanical Engineering, M.E. 31. Gas Power Plants. Choice of source of motive powers for given project; economics of gas power development, management and operation; apparatus and machinery in use in modern gas power plants, gas producers and accessories, scrubbers, cleaners, etc.; fuels and processes; design, specification, bill of material, tracings and blue prints for project. Prerequisite, M.E. 7. II.; arrange time; (1). Professor Willhofft.

Drawing 41. Technical Photography. A study of apparatus, optics of photography, exposure, developers, fixers, dry plates, developing papers, printing-out papers, toning, blue-print processes, Van-Dyke solar process, lantern slide making, progress photographs of engineering structures, etc. Lectures and laboratory practice. Prerequisites, Chemistry 1, Physics 1. II.; arrange time; (1). Professor Derr.

Home Economics 9. Bacteriology. This course is designed to give the student a good working knowledge of general bacteriology, with special problems in household bacteriology and pathogenic forms found in food supplies. II.; arrange time; (1) or (2). Miss Irma Hale.

NOTES OF THE STUDENT ORGANIZATIONS.

Young Men's Christian Association. The Association has thus far enjoyed a very successful year. Its meetings are continually increasing in interest, which is manifested by the large attendance.

Although the active membership is but slightly larger than a year ago, the attendance at the meetings has nearly doubled. About twelve new members have been enrolled. Meetings are held every Friday evening, at 7 o'clock, to which all students are cordially invited.

Among the recent events of the association is that of a joint meeting with the Normal Y. M. C. A., held in the Clarkson Chapel, Jan.6. At this meeting Mr. J. H. Safford, Secretary of Student Committee of the New York State College Y. M. C. A's., was present and conducted the meeting. The following evening Mr. Safford spoke to a large audience in the Presbyterian church. Mr. Safford is a graduate of Yale, and a very interesting talker. He explained how association work is being successfully conducted all over the State. His chief object in visiting the two associations in Potsdam was to secure delegates for the Nashville convention, to be held Feb. 28 to March 4, 1906.

The following officers have been elected for the ensuing year, beginning with the second semester:

Grant Tracy, '08.. .. ..President.
A. C. Meacham, '07.. .. ..Vice President.
C. L. Cochrane, '08.. .. ..Secy. and Treasurer.

Clarkson Athletic Association. Now that the football season is over, basket-ball is occupying the attention of the Association and the students. Several hotly contested games of basket-ball have already been played.

The work of the Clarkson team is certainly to be praised by all, considering the difficulties under which it has had to play. This team, without a gymnasium in which to obtain practice as one of the most essential things necessary to any kind of athletic sport, is bucking against teams trained and developed by all kinds of gymnasium exercise and practice, which are especially important in the indoor game of basket-ball. Nevertheless, we have never yet been ashamed of any of our team work. Taking into consideration what has been done, it is evident that very much more might be done if our team had a gymnasium in which to obtain proper training.

Our base-ball manager is looking for an early spring, that his team may begin work as soon as possible, and so be in shape for the season's schedule which he is trying to arrange in such a way as to make it the best we have ever had.

Clarkson Musical Association. The Glee Club has secured the services of Miss Claire L. Mann as instructor, and is doing very creditable work considering the loss of several of its old members who graduated last June, 1905.

The orchestra, under the direction of Mr. Loy E. Welker, '09, is working hard, with a view of giving a concert in the spring.

CLARKSON SUMMER SCHOOL.

Third Session—1906.

The object of holding this summer session of six weeks, is to offer the facilities of the school and to provide instruction for teachers and advanced and special students, and those who are preparing to pass the grade and State examinations in August; for college students who through failure in any course wish to prepare for September examinations; and for those who are preparing to enter college.

COURSES OF INSTRUCTION.*

Electrical Engineering. Course in elementary and applied electricity, lectures, problems and laboratory work, will be given if a sufficient number apply for it.

History and Literature. Courses in English and American Literature; Ancient, Medieval and English History.

Languages. Courses offered in ancient and modern languages, for beginners or advanced students and teachers, including Latin, Greek, French, German and Spanish.

Mathematics. Courses offered in advanced Algebra, Solid Geometry and Trigonometry.

Home Science. Courses in Cookery, Sewing, Basketry, and Sloyd; lectures, laboratory work, individual instruction; with special reference to the needs of those preparing to teach Home Science.

Manual Training. Courses in bench work in wood and Venetian ironwork, combined with constructive drawings and making models and ornamental designs.

EXPENSES.

The tuition will be from $5.00 to $12.00 per subject, according to branches and character of work taken. Expenses for laboratory and other materials necessary will be charged at cost, as may be required. All students taking courses in practical work will be charged for injury to apparatus and for breakages.

Boarding. Excellent boarding arrangements may be made, at reasonable rates, as given in this Bulletin, under the item of expenses for attending the Clarkson School of Technology.

Circulars containing full information of each of the courses announced will be sent upon application to

Carl Michel, Ph.D.,
Secretary, Clarkson Summer School,
Potsdam, N. Y.

July 5, Thursday.. .. ..Instruction begins
August 16, Thursday.. .. ..Instruction ends

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*If the arrangements for instruction during the summer make it possible to give other courses, they will be announced in the next issue of Clarkson Bulletin.

WEATHER REPORT.

Report to Dec. 31, 1905.	Average.				Totals.	
Observations made at Clarkson School of Technology, Potsdam, N. Y.	Temperature.			Barom inches.	Precip. inches.	Snow inches.
	max.	min.	mean.			
Month ending July 31, 1905	80.2	59.7	69.9	29.55	7.47	
" " Aug. 31,	77.2	54.3	65.3	29.61	3.58	
" " Sept. 30,	71.3	49.0	59.9	29.66	2.06	
Week ending Oct. 7, 1905	71.0	48.8	59.9	29.64	1.34	
" " " 14,	59.0	39.5	51.5	29.56	1.07	
" " " 21,	63.2	40.1	51.7	29.62	0.70	
" " " 28,	47.8	28.1	37.6	29.75	0.26	
" " Nov. 4,	45.4	26.5	35.4	29.78	0.40	
" " " 11,	40.5	28.8	35.4	29.50	0.80	
" " " 18,	38.1	22.0	29.6	29.40	0.26	7.0
" " " 25,	44.1	24.8	34.4	29.85	0.00	
" " Dec. 2,	39.2	18.40	28.1	29.79	1.41	2.0
" " " 9,	35.4	21.3	28.0	29.87	0.90	9.0
" " " 16,	18.1	−2.5	9.0	29.76	0.65	8.0
" " " 23,	30.4	15.7	25.2	29.68	1.20	6.0
" " " 30,	40.4	22.3	31.3	29.44	1.10	7.0
Month ending Oct. 31,	59.3	37.0	48.1	29.67	3.69	
" " Nov. 30,	42.0	25.0	33.5	29.62	2.44	8.5
" " Dec. 31,	31.2	14.3	26.9	29.69	4.00	30.5

The precipitation includes all rain fall and snow melted.

Thomas S. Clarkson
Memorial
School of Technology
Potsdam, N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language, literature and history, mathematics, the natural and economic sciences, engineering and technology. The instruction is largely taken in common, during the first two years, and provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of the applied sciences, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting investigations.

The technical instruction of the last two years, in theory and practice, affords substantial preparation for immediate usefulness after graduation by intelligent application of principles to the successful mastery of the details of the chosen field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their profession.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical or mechanical engineering. The four year course in home economics for women offers a full college training, whose aim and scope are to prepare for teaching home economics, as well as for the efficient management and supervision of the home.

These courses of instruction lead to the degree of Bachelor of Science in the major subject pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

CLARKSON BULLETIN

Vol. III. APRIL, 1906. No. 2.

THOMAS S. CLARKSON

MEMORIAL

SCHOOL OF TECHNOLOGY

POTSDAM, N. Y.

ISSUED QUARTERLY BY

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

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1906

Clarkson Bulletin

Potsdam, N. Y.

Issued Quarterly by

Thomas S. Clarkson Memorial School of Technology.

1906

Clarkson Bulletin

Vol. III. APRIL, 1906. No. 2.

CONTENTS OF THIS NUMBER.

Contents of Clarkson Bulletin, Vol. III., No. 1.

Announcement: The Clarkson Bulletin is published quarterly

It will be mailed upon application to

The Director,

Clarkson School of Technology,

Potsdam, N. Y.

CALENDAR

1906-1907

II. Semester, 1906.

Jan. 29, Monday	Instruction begins.
Feb. 12, Monday	Lincoln's Birthday.
Feb. 22, Thursday	Washington's Birthday.
March 19, Monday	Charter Day, Decennial anniversary of the granting of the Charter.
April 12, Thursday (evening)	Spring recess begins.
April 24, Tuesday	Instruction resumed.
May 30, Wednesday	Memorial Day.
June 1, Friday	Day for depositing theses in Library.
June 10, Sunday	Baccalaureate Sunday.
June 11, Monday	Semester examinations begin.
June 13, Wednesday	Annual meeting of Trustees.
Juue 14, Thursday	Examinations close.
June 15, Friday	Seventh Annual Commencement.

I. Semester, 1906-1907.

Sept. 11, Tuesday	Registration of matriculated students. Matriculation of new students.
Sept. 12, Wednesday	Instruction begins.
Nov. 10, Saturday	Last day for announcing subjects of theses for baccalaureate degree.
Nov. 29, Thursday	Thanksgiving Day.
Nov. 30, Friday	Founder's Day. Decennial Commemoration.
Dec. 12, Wednesday	Semi-annual meeting of Trustees.
Dec. 22, Saturday (noon)	Christmas recess begins.
Jan. 2, Wednesday	Instruction resumed.
Jan. 24, Thursday	Semester examinations begin.
Jan. 26, Saturday	Examinations close; end of I Semester

II. Semester, 1907.

Jan. 28, Monday	Instruction begins.
Feb. 12, Tuesday	Lincoln's Birthday.
Feb. 22, Friday	Washington's Birthday.
March 19, Tuesday	Charter Day.
March 28, Thursday (evening)	Spring recess begins.
April 9, Tuesday	Instruction resumed.
May 30, Thursday	Memorial Day.
June 1, Saturday	Day for depositing theses in library.
June 9, Sunday	Baccalaureate Sunday.
June 10, Monday	Semester examinations begin.
June 12, Wednesday	Annual meeting of Trustees.
June 13, Thursday	Examinations close.
June 14, Friday	Eighth Annual Commencement.

OFFICERS OF INSTRUCTION

WILLIAM SLEEPER ALDRICH, M. E.,
Director

FRANK MARION WILLIAMS, A. M.,
Professor of Chemistry

WALTER SCOTT GRAFFAM, B. S.,
Superintendent of Shops

BYRON BRIGGS BRACKETT, A. M., PH. D.,
Professor of Physics and Electrical Engineering

FREDERIC OTTO WILLHOFFT, M. E., A. M.,
Professor of Mechanical Engineering

CARL MICHEL, A. M., PH. D.,
Professor of Social Science and Modern Languages

MYRA BREWSTER CLARKE, A. B., A. M.,
Professor of Home Economics

HOMER MUNRO DERR, A. M., Ph. D.,
Professor of Mathematics and Civil Engineering

GEORGE ALBERT LITTELL,
Instructor in Shopwork and Mechanician

CHARLOTTE DEZELL SEAVER, B. S.,
IRMA HALE, B. S.,
Assistants in Home Economics

FRANCIS PATRICK CUMMINGS,
Tutor in Mathematics

FRANK HEATH FLINT,
Assistant in Surveying.

ARTHUR BENDER McINTYRE,
Librarian

Thomas S. Clarkson
Memorial
School of Technology

(Copy of the original charter.)

UNIVERSITY OF THE STATE OF NEW YORK

CHARTER OF

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

Whereas, A petition for incorporation as an institution of the University has been duly received, and

Whereas, Official inspection shows that suitable provision has been made for buildings, furniture, equipment and for proper maintenance, and that all other prescribed requirements have been fully met

Therefore, Being satisfied that public interests will be promoted by such incorporation, the Regents by virtue of the authority conferred on them by law hereby incorporate

Elizabeth Clarkson, Frederica Clarkson, Annie Clarkson, Abraham X. Parker, John G. McIntyre, George H. Sweet, Edwin A. Merritt and their successors in office under the corporate name of Thomas S. Clarkson Memorial School of Technology with all powers, privileges and duties, and subject to all limitations and restrictions prescribed for such corporations by law or by the ordinances of the University of the State of New York. The first Trustees of said corporation shall be the seven above named incorporators. This corporation shall be located at Potsdam, St. Lawrence County, New York, and may grant diplomas to all students who complete the regular courses of instruction, and certificates to those completing special work. All graduates who shall have satisfactorily completed the course of study and the examinations required and shall have been recommended by the Trustees for the degree of Bachelor of Science, shall receive from the University the degree B.S. certified by a diploma bearing the seals and the official signatures both of the institution and of the University of the State of New York.

In witness whereof, the Regents grant this charter No. 999 under seal of the University, at the Capitol in Albany, March 19, 1896.

(Signed) Anson Judd Upson, Chancellor.

(Signed) Melvil Dewey, Secretary.

1896 — DECENNIAL YEAR — 1906

COMMEMORATIVE EXERCISES.

Observance of Washington's Birthday.

The first commemorative event of the Decennial year of the Clarkson School of Technology was the observance of Washington's Birthday. Thursday, February 22, 1906. Appropriate exercises were held in the Chapel Hall of the School at eight o'clock in the evening. The hall and platform were tastefully decorated with the national flags and the Clarkson Tech. colors. The following interesting program was rendered:

Program.

Overture—Selection,.. .. ..Opera "Woodland"
Welker Orchestra.

Hymn—"Flag of the Free",.. .. ..Lohengrin

Scripture Reading.
Hon. George Lewis.

Prayer.
Rev. Dr. Schulte.

Hymn.. .. .. "Rise, Crowned with Light"

Reading of Students' Prize Papers on Arbitration.

Solo—Selected, ..."The Two Grenadiers"
Mr. L. E. Ginn.

Address—"Washington and Franklin: Eighteenth Century Prophets of Twentieth Century History.
Director Wm. S. Aldrich.

Hymn—"America."

Benediction.

The orchestra was under the leadership of the Messrs. Welker Bros., '06. The result was announced of the Clarkson Tech. prize competition of papers submitted on "Arbitration", and Mr. John McNulty, '09, and Miss Lucy Fulton, '07, (Home Economics Course) were called to the rostrum to read their papers.

"Your young military men who want to reap the harvest of laurels, do not care, I suppose, how many seeds of war are sown; but for the sake of humanity, it is devoutly to be wished that the manly employment of agriculture and humanizing benefits of commerce would supercede the waste of war and the rage of conquest; that the swords might be turned into plowshares, the spears into pruning hooks, and as the Scriptures express it: 'the nations learn war no more.'—Washington to the Marquis de Chastellux.

Franklin anticipated that the general peace of Europe might be secured if the powers would "refer all disputes between each other to some third person, or set of men, or power. Other nations, seeing the advantage of this, would gradually accede, and perhaps in one hundred and fifty or two hundred years all Europe would be included."

CHARTER DAY EXERCISES.

1896 — Decennial Year. — 1906

An appreciative audience gathered in the Chapel Hall of the Clarkson School of Technology on Monday evening, March 19, to commemorate the granting of the charter ten years ago, March 19, 1896. For the past six months, from the day the school opened, last fall, and began the work of this, its decennial year, preparations have been in hand for the event. The result of the co-operation on the part of the Founders, the Trustees, the Faculty, the Alumni and graduates, and the students was an occasion which marks an epoch in the history of the school.

The hall was decorated with the National and the Clarkson Tech. colors in flags, festoons, rosettes and banners. The platform was lined with ferns, potted plants and vases of cut flowers of Easter lilies. The electric display was new and original, consisting of "1896" on the east wall, and "1906" on the west wall, in minature incandescent lamps trimmed with the Tech. colors and banners, and a device "C. S. T." was similarly arranged over the platform.

The printed program was bound with old gold ribbon in neat double leaflets, between olive green covers. It comprised the following:

Program.

Overture—Yankee Consul,.. .. ..Robyn

Orchestra.

Scripture Reading.

"Just a Song at Twilight",.. .. ..Molloy

Vocal Quartette.

Invocation.

Clarkson Decennial March,...... .. ..Arr. by S. S. Stone, '05.

Orchestra.

Responses:

The Board of Trustees,
Hon. Edwin A. Merritt, LL.D.

Selection—Fantana,.. .. ..Hubbell

Orchestra.

The Faculty,
Frank Marion Williams, A.M., Professor of Chemistry.

Selection—Singing Girl,.. .. ..Victor Herbert

Orchestra.

The Alumni and Graduates,
Charles Andrew Pohl, '02, B.S. in Civil Engineering.

Clarkson Favorites,.. .. ..Arr. by S. S. Stone, '05

Orchestra.

The Students,
Abel Farrington Simpson, '06.

"Floating 'Mid the Lilies",.. .. ..Atkinson

Vocal Quartette.

Benediction.

THE THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

This Institution was founded in 1895. It was chartered March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to the students in September of the same year. The object of the Clarkson Foundation is to provide technological education of college grade. For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language and literature, the applied and economic sciences, engineering and technology. They lead to the degree of Bachelor of Science in the major course pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree is conferred by the Regents of the University of the State of New York upon the recommendation of the Faculty to the Board of Trustees of this Institution.

The school is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

Building.

The main building of the school is 87x57 feet, and has two wings, each 180x36 feet. All is built of carefully selected Potsdam red sandstone, finished inside in quartered oak and hard pine, with hard-wood floors. It is substantially of fire-proof construction, ventilated by fans, heated by both direct and indirect steam radiators and lighted by electricity. In the main building are the Director's office, library, recitation rooms, chemical and physical lecture rooms, physical and home science laboratory, drafting rooms, and the assembly hall with a seating capacity of 500. In the basement are the boiler rooms, photometer room, photographic dark room, laundry, toilet rooms and lockers. The east wing is occupied by the wood-working shop, the machine shop and the steam engine and dynamo rooms. In the west wing are the chemical laboratory, the electrical and mechanical engineering laboratories and the forge shop.

Library.

The library of the school contains a classified and indexed collection of standard and latest books in the lines of the school's work; the transactions of scientific and engineering societies; and selected American and foreign technical journals and periodicals.

Chemical Laboratory.

The chemical laboratory is provided with tables, fitted with porcelain sinks, plate glass shelves for reagent bottles, and every convenience for handling experimental apparatus and work. The hoods for use in the generation and manipulation of noxious gases are exhausted by power fan. The facilities for advanced experimental and research work are excellent. The equipment includes several sets of extremely delicate analytical balances, assay balances, power crushers, ore grinders, furnaces and other accessories for gold and silver assaying, an electric furnace for metallurgical work, a New York State legal oil tester, a Doolittle torsion viscosimeter together with the hydrometers, Westphal balances, etc., for the examination of fuel and lubricating

oils; the standard forms of apparatus for gas analysis, and a Mahler bomb calorimeter for the exact determination of the heat value of coal, oil and other kinds of fuel.

Owing to an increasing appreciation of the importance of a knowledge of the microscopic structure of the materials of construction, the school now offers facilities for work of this nature. The apparatus for this work includes two microscopes with vertical illuminators and camera holder, one six-spindle polishing machine, one electric projection lantern with condensing lenses for illumination of specimen, together with a well-equipped dark room for the photographic work.

Laboratory of Physics.

The laboratory of physics is devoted to instruction in general physical measurements. Special rooms are provided for light and electrical measurements and dark rooms for photometry and photography. The laboratory is provided with apparatus for general physical measurements in mechanics, light and heat, and is well equipped with instruments for electrical measurement, including tangent, D'Arsonval, ballistic and Kelvin galvanometers, improved form of Carey-Foster bridge, meter bridges, condensers, Wheatstone bridges of simple and of the Anthony form, resistance boxes, special megohm resistances and apparatus for the measurement of induction and the magnetic qualities of iron. The photometer room contains a Reichsanstalt photometer of the latest design, having a three-meter scale and provided with accessories for the measurement of artificial light, including gas, arc and incandescent lights.

Electrical Engineering Laboratory.

The electrical engineering laboratory includes in its equipment two 25 kilowatt 110-volt direct-current compound dynamos, a 7½ kilowatt rotary converter, arranged for operating as a single, two or three-phase machine, a 5 kilowatt low-tension three-phase alternator, two 10 horse-power and one 5 horse-power shunt motors, transformers of different types and sizes and several small generators and motors, including examples of the polyphase induction type.

Two one-kilowatt machines designed as rotary converters are arranged to illustrate methods of testing direct and polyphase-current machines.

The laboratory is provided with apparatus for determination of wave forms, is well equipped with wattmeters, direct and alternating-current ammeters and voltmeters, and contains suitable standardizing apparatus.

Mechanical Engineering Laboratory.

The power plant of the school consists of two 80 horse-power horizontal tubular boilers; two 40 horse-power vertical high speed engines direct-connected to multipolar dynamos; one 80 horse-power Wheeler surface condenser; one 15 horse-power Otto gas engine; a duplex steam pump and 10 horse-power steam engine, the whole being specially arranged for experimental work, constitutes an important part of this laboratory equipment.

The laboratory is also supplied with an Olsen testing machine of 100,000 lbs. capacity, for tension and compression tests of specimens six feet long, with an attachment for making transverse tests of beams and trusses up to sixteen feet in length; an Olsen torsion machine of 200,000 inch-lbs. capacity, for torsion tests of shafting up to 2½ inches

in diameter and sixteen feet in length; and a Fairbanks machine of special design for testing the strength of cements. Additional apparatus, consists of calorimeter for determining the heating value of coal and other fuels; steam-engine indicators, planimeters, scales, gages, thermometers, extensometers and other measuring instruments; injectors, steam flow apparatus; pressure tank and weir box for hydraulic experiments; a Venturi meter and other water meters are also part of the laboratory equipment. As are, likewise, other pieces of apparatus such as prony brakes; absorption and transmission dynamometers; indicator spring testers; belt testers; and other devices designed and made at the school.

Home Economics Laboratories.

The equipment of the kitchen includes a complete set of cooking utensils for twelve students; coal, gas and gasoline stoves; cupboards; refrigerator; meat and food charts; silver, linen, china, etc. That of the sewing room includes a suitable assortment and arrangement of tables, chairs, cabinets, samples and sewing machines. The laundry contains eight stationary tubs, wash boards, dry room, ironing boards and sets of flat irons.

Workshop Equipment.

The wood-working shop contains twenty-four benches, twenty 10-inch lathes, one 16-inch lathe with 10-foot bed and overhanging face-plate, capable of turning work up to 80 inches in diameter, 24-inch surfacing planer, 18-inch buzz planer, a universal rip and crosscut saw and a band saw.

The machine shop has ten screw-cutting engine lathes, two speed-lathes, a 20-inch upright drill, a sensitive or friction drill, a Whitcomb 20-inch planer with 6-foot bed, a Landis universal grider, a Cincinnati universal milling machine, a Gould and Eberhardt shaper, a power hack-saw, a grindstone, a water emery grinder, small bench grinder, a Worcester universal drill grinder, an arbor press, a gas tempering furnace, a small crucible furnace for tempering in molten baths, and twenty-four vise benches arranged for instruction in vise work. The tool-room adjoining contains a well selected variety of machinists' small tools and appliances. These are loaned to the students upon the check system.

The forge shop has twenty-four forges and anvils, and necessary small tools, shears, blacksmiths' drill, bolt-header, vises, swage-block, etc. A few forges are equipped with hand-blowers in addition to motor-driven power blast.

The foundry equipment at the school consists of a brass furnace, a gas-melting furnace, a core oven and the usual small tools and flasks for moulding.

"The problems to be solved in this industrial situation are to a certain extent technical, it is true; but the larger number of factors entering into their solution are almost entirely social in their nature. The elements to be dealt with are too distinctly human; and, intelligence being present, more can be accomplished by the application of reason where mental attainments are on the same plane, or by conciliation and arbitration where they differ, than by the application of might for the purpose of crushing opposition."—Holbrook F. J. Porter, M.E., Founder's Day Address, 1902.

EDUCATION FOR ENGINEERING PROFESSIONS AT THE CLARKSON SCHOOL.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical and mechanical engineering. The instruction taken in common during the first two years provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of engineering science, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting tests and researches.

The technical instruction of the last two years, in the theory and practice of engineering, affords the student substantial preparation for immediate usefulness in engineering workshop or laboratory, office or field, by intelligent application of principles to the successful mastery of his field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their chosen profession.

This school is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

Chemical Engineering.

The instruction in this course is designed to be such as will give the student a thorough grounding in the fundamental principles of engineering, together with such training in chemistry—general, analytical and industrial—as will enable him to be of service in the design, construction, and operation of chemical plants and the development of processes involving a knowledge of chemistry. During the last two years of the course considerable opportunity is given the individual student of selecting work along those particular lines which he intends to follow after graduation.

Civil Engineering.

The above course, as distinct from the courses in chemical, electrical and mechanical engineering, includes railway, structural, municipal, mining and geodetic engineering. As an example of the lines of work taken up the following special features may be noted: In railway engineering, a railroad line is located, cross-sectioned, and staked out in detail, with complete maps and profiles, computations of earthwork and costs. Structural engineering includes courses in bridges and roofs, structural design, building construction, masonry and foundations. Municipal engineering comprises water analysis, hydraulics, water works, sewerage construction, sanitary science, roads, street pavements and city surveying. Mining engineering embraces geology, mineralogy, mining methods and surveys, and assaying. Geodetic engineering includes especially hydrographic surveying and geodesy, fitting graduates to take positions in the United States Coast Geodetic and Lake Surveys.

Electrical Engineering.

This course is designed to fit young men to engage intelligently in the production and operation of electrical apparatus and in the application of electricity to the arts and sciences. It provides, besides

foundation work, such as physics, chemistry, mathematics, mechanics, and drawing, specialized studies in electricity and applied electricity. These involve the theory of electricity and magnetism, and their application to direct-current machinery and electrical measuring instruments; the theory of alternating currents and alternating-current machinery, comprising alternators, synchronous and induction motors, rotary converters and rectifiers. Courses are also given in electrical distribution, electric lighting, and the art of illumination and in electric power plants, traction and transmission. These include the solution of problems naturally arising in the commercial generation, transmission, distribution and utilization of electric energy. Work in the electrical engineering laboratories is co-ordinated, as far as possible, with the lectures and recitations, and aims to give a study of the methods of electrical measurements, practical knowledge of the testing and handling of electrical machinery and accurate photometric measurements.

Mechanical Engineering

This course considers the development of power and its transmission and utilization by machinery. It treats of the principles of machine design, with applications of the same; power development by steam and gas engines and hydraulic motors; experimental study of strength and characteristics of various constructive materials; methods and practice of economic workshop production and mechanical construction; tests of motive-power machinery and powe plants; calibration and standardization of instruments and apparatus used in measuring power; and other work appertaining to the profession of mechanical engineering.

TRAINING IN HOME ECONOMICS AT THE CLARKSON SCHOOL.

Four Year Course.

There has been established a four year course leading to the baccalaureate degree which offers to women a full college training in the applied and economic sciences. Its aim is thoroughly to prepare them for teaching the technical branches of Home Economics as well as for the efficient management and supervision of the home. It offers the opportunities and commands the prestige inherent in every college course in the applied sciences. It has in common with other courses in this school, been approved, January 21, 1902, by the Regents of the University of the State of New York, under whose charter the institution is organized and the degrees conferred.

This course for women is arranged to parallel the regular engineering courses given in this school to men. It comprises instruction in the vocations within woman's sphere as the engineering courses comprise instruction in the professions of men.

During the first two years the work is taken with and is similar to that prescribed for the other four year students, except in the substitution of work in home economics for shopwork, surveying, etc. In the last two years of specialized instruction considerable work is likewise taken along with the engineering students. Each senior in this course is required to conduct twenty exercises in practice teaching—ten in cooking and ten in sewing.

Two Year Course in Home Economics.

This is a special course for those preparing to teach Home Economics in public and private schools. It affords also an excellent training in those subjects which must be considered in the daily care of the home. The course includes the following work, taken along with the students enrolled in other courses: English, French or German, chemistry, sociology, economics and all the regular courses given in the department of home economics. These include the following: Textiles, laundering, dietetics, foods, their composition and production, home sanitation, economy, and nursing, physiology and personal hygiene, theory and practice of teaching home economics, plain sewing, drafting and dressmaking, basketry, and bacteriology. For description of these courses, see pages 70, 71.

Electives may also be chosen from the regular courses of instruction elsewhere described.

The requirements for admission to this two year course are the same as for the four year course in Home Economics; namely, the satisfactory completion of a regular four year high school course of instruction, certified by an academic diploma or an equivalent academic certificate, issued by the Education Department of the State of New York.

Each student during the last year is required to conduct a number of exercises in practice teaching, cooking and sewing. A thesis is also required representing an amount of work equivalent to one semester hour and subject to the conditions stipulated for theses, page 56.

For tuition and other expenses, see below.

There will be given a certificate in Home Economics, signed by the Director, and the President and Secretary of the Board of Trustees, upon satisfactory completion of all required work in this two year course, as scheduled on page 61.

EXPENSES.

Tuition.

Annual tuition, for each of the four year courses and for the two year course in Home Economics, $100.00.

The tuition is payable in semi-annual installments, at the beginning of each semester and by all matriculated students.

An admission fee, of $5.00, will be charged all students on and after September 11, 1906, upon their admission to the School as regular students or as special students in any course of at least ten semester hours.

Students who enter upon any course or semester of work before one-quarter of it is finished, and make up the back work, receiving full semester credit for all of the work of that semester, are not allowed a rebate in tuition. Non-matriculated students who enter upon any course or semester of work after one-quarter of it is completed, are allowed proportionate rebate of tuition.

The following schedule of charges for special courses will be applied, as based upon the semester hour credit to be granted, to all courses which are taken in excess of the semester hours scheduled for the class in which the student may be registered for any one year,

whether such work is an advanced or other course required for graduation, an elective course, or one taken to make up a condition or a failure.

The same scale of charges will be applied to the courses in advanced algebra and solid geometry, taken by students to make good their matriculation conditions in these subjects.

Matriculated students taking less work than that represented by the semester hours scheduled for the class in which they may be registered will be charged the regular tuition; provided, that they are registered for at least fifteen (15) semester hours, otherwise their tuition will be based upon the schedule below.

Non-matriculated freshman and special students, taking from fifteen (15) to eighteen (18) semester hours of work per week pay the regular tuition; otherwise, their tuition is based upon the schedule below.

Any subject required to be taken over again in class, or by special arrangement with the Instructor, will be charged according to the schedule below as though it were special course.

Subjects which are required to be taken over in class, or, which are taken by special arrangement with the Instructor, are not to be included in the semester hours scheduled for the class in which the student may then be registered; but, they will be charged separately as special courses, and in addition thereto, according to the schedule below.

An advance examination fee, of $5.00, will be charged for the second or re-examination in any subject, or, for an examination in any subject taken in lieu of an assigned final examination from which the student was absent.

An annual fee, of $10.00, will be charged all students in Home Economics, who enter on and after September 11, 1906, in regular courses, or in special courses of at least ten semester hours, to cover cost of supplies and materials used in practical work.

Graduation fees will be charged as follows; beginning with classes graduating, June 1909:

Four year course, for B.S. degree..	$10.00
Two year course, for certificate in Home Economics ..	5.00

Charges for Special Courses.

Courses of lectures, recitations and class room work: per semester hour, one hour, weekly for eighteen (18) weeks	$2.50
Shopwork, drafting, surveying, chemical and physical laboratories; cooking and sewing: per semester period, one three hour period weekly, for eighteen (18) weeks..	$5.40
Electrical and mechanical engineering laboratories: per semester period, one three-hour period, weekly, for eighteen (18) weeks..	$9.00

Deposit.

To ensure the prompt return whenever required, and in good order, of chemical, physical and engineering apparatus and tools; of keys to lockers and drawing and laboratory tables; and to defray any

incidental expense incurred by breakage or injury to property, an annual deposit is required of all students, as follows:

Annual deposit for the four year courses..	$10.00
Annual deposit for the two year Home Economics courses	2.00

The unexpended balance will be returned at the end of the year.

Cost of Living.

Owing to the large number of inquiries of prospective students as to the cost of living in Potsdam, the following schedules have been compiled. Experience has shown that these values represent good average rates.

Rooms: Single..		$0.75 to $1.25
Double..		1.00 to 2.00
	Table Board.	Board and Room.
Club rates..	$2.75 to $3.50	$3.00 to $4.00
Single rate..	3.25 to 4.00	3.50 to 4.50

Estimated Expenses for a School Year of Thirty-Six Weeks.. .. ..

Tuition..	$100.00	$100.00
Deposit fee..	10.00	10.00
Books, stationery and instruments..	30.00	35.00
Room and Board..	126.00	144.00
Washing and laundry..	10.00	15.00
	$276.00	$304.00

To the above estimate for a school year should be added traveling expenses, clothing and such miscellaneous items as depend largely upon individual habits and manner of living, which, from the actual experience of students may be kept within from $75 to $100 for the thirty-six weeks. There are no dormitories attached to the school.

LEVINUS CLARKSON SCHOLARSHIP.

At the Charter Day Exercises, held in the Assembly Hall of the School, March 19, 1906, in commemoration of the decennial anniversary of the granting of the Charter, the following communication was read, at the close of his address, by Hon. Edwin A. Merritt, LL.D., member of the Board of Trustees:

Thomas S. Clarkson Memorial School of Technology Scholarship.

We, the undersigned, agree to pay on Charter Day, March 19th, of each year, One Hundred Dollars, ($100) to be applied to the establishment of a Scholarship to be known as the "Levinus Clarkson Scholarship", and, to be awarded to a candidate nominated by the Director of said School.

Said Scholarship is further to be held only on condition of the attainment of an average standing in studies, and of deportment satisfactory to the School authority.

March 19, 1906.

(Signed) Elizabeth Clarkson.
(Signed) Frederica Clarkson.

This scholarship will be awarded to the student whose record is in every way above question, as based upon the work and deportment

of previous years, and who gives the most promise of future professional success.

The award will be made on Founder's Day, November 30, each year, and applied to the current college year.

STUDENT ORGANIZATIONS.

Young Men's Christian Association. In every educational institution, of college grade, the need from time to time is peculiarly felt of an organization that will weld all of the interests and bring into effective operation all of the forces, that always exist in the student environment, making for righteousness and highest moral action. The college branches of the Young Men's Christian Association, now so fully established throughout the world, have seemed more fully to meet these requirements than any other existing college organization whose sole aim is the moral betterment and spiritual uplift of the student life. The students and members of the Faculty effected such an organization in the Clarkson School of Technology October 10th, 1904, with suitable committeemen appointed to arrange for intercollegiate relations. The college Y. M. C. A. Constitutions has been adopted.

Clarkson Musical Association. This association is composed of the Glee Club, the Mandolin Club and the Orchestra. It is organized under a Board of Directors, comprising the officers of the Association and those of the three musical clubs.

Clarkson Athletic Association. An Athletic Association is maintained by the students, under the management of which all forms of athletic sports are conducted. This association is supported by student subscriptions paid annually. It is an organization whose object is to promote the physical welfare and activities of the students by outdoor games and to encourage and maintain a proper spirit in favor of hearty, manly sports.

The council of six members of the association is annually elected by the student body with which the committee of the Faculty on athletics holds advisory relations. The council has general supervision of all athletic sports and contests, passes upon eligibility of players arranges the schedule of games, and seeks to foster honesty and fairness in all atheletic sports. Each and every member of an athletic team representing the school in intercollegiate contests must be a regular accredited student. For details regarding membership in athletic teams, see Handbook.

Fraternities. The following fraternities have been organized at this institution: Omicron Pi Omicron, founded, November 9, 1903; and Sigma Delta, founded, March 17, 1904. They have been formed to enter unoccupied fields, to fill imperative needs for organizations that would bring the members of different classes together on a common plane. In this way they seek to unite the student body more thoroughly than could be effected by any class organization. Their purpose is to promote harmony and good fellowship among their members and to maintain a high standard of manhood. Intellectual and moral qualifications are considered for membership and in this way an influence is exerted for the betterment of student work and life. Their activities are social and professional rather than literary, and the development of the fraternal spirit is their chief work.

RULES AND REGULATIONS.

Class Officers. All matters pertaining to the general welfare of the individual student; the arrangement of courses, studies and work; the withdrawal of books from the library; deportment, absences and reports, are primarily vested in the Class Officer, according to the following assignments: Students in chemical engineering to Prof. Williams; civil engineering to Prof. Derr; electrical engineering to Prof. Brackett; mechanical engineering to Prof. Willhofft; all freshmen and sophomores to Prof. Michel; specials in engineering to committee, Director, chairman; home economics to Miss Clarke.

Registration. In all cases this must conform to the sequence of required work as indicated by the prerequisites of each course. No student will be allowed to register for more than twenty semester hours except by special permission of the Faculty.

Attendance. Regular attendance on school exercises, including chapel services, is expected of all students.

Reports. Reports of standings of all students are made to the Faculty at the middle and at the close of each semester. Copies of all reports are sent to each student's parent or guardian, except the mid-semester reports of standing of juniors and seniors.

Order. Good order and gentlemanly deportment are required as a condition of attendance.

Smoking is prohibited in the buildings and grounds of this school.

Full details of the organization and management of the school will be found in its "Handbook", published by the authority of the Board of Trustees. Copies of this will be mailed upon application to the Director.

REQUIREMENTS FOR ADMISSION.

The requirements for admission to all regular courses in the Clarkson School of Technology are established by the Regents of the University of the State of New York. The following excerpt* from the University rules sets forth the preparation required:

"No degree shall be conferred for completion of a course of study or on examination, unless the candidate has a preliminary general education, at least a four year high school course or its full equivalent as determined by University rules. Satisfactory evidence of such preliminary education must be offered before beginning the course of study for the degree, and any condition or deficiencies (which must not exceed three academic subjects, i. e. 15 counts) must be made up within one year."

Matriculation, September, 1906.

Candidates for matriculation in this school must have complied with the above ruling. The standard required for the class entering September, 1906, is represented by a 60 count academic diploma page 52, such as granted by the New York State Education Department. Each "count" represents a lesson a week for a school year (see Handbook 3, December, 1905, New York State Education Department).

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*University of the State of New York, College Department, Annual Report 1898, Vol. I., p. 10.

New York State Education Department Diplomas.

For applicants for admission to this Institution who present New York State Education Department diplomas, the following shows the grouping of required and elective work in the total of 60 counts, required for the academic diploma, June 1, 1906, and necessary for admission for the class entering September, 1906:

Required Subjects.	Counts.
English	10
Algebra	5
Intermediate Algebra	2
Plane Geometry	5
Solid Geometry	2
Science, Group 3*	7½
History and Social Science, Group 4*	7½
Counts in required academic subjects	39
Advanced Algebra, required for matriculation in Clarkson School of Technology	3
Counts in elective or optional academic subjects	18
Total academic counts required for matriculation	60

All credits earned before June 1, 1906, will be recorded as heretofore. When these credits are applied to credentials issued subsequent to June 1, 1906, their value will be increased 25 percent (except in certain cases of equivalence), since 12 counts old are exactly equivalent to 15 counts new.

College Entrance Examination Board Certificates.

Applicants who have taken examinations under the auspices of the College Entrance Examination Board* will be granted such an academic equivalent certificate by the New York State Education Department, as may be represented by the high school work satisfactorily covered by these examinations. If the total work thus certified is equivalent to an academic diploma issued by the Department, as above. and including advanced algebra and solid geometry the applicant will be admitted to matriculation in this school without further examination.

Accredited Academic Certificates and Diplomas.

Candidates not holding Department certificates and those from other states and from Canada, or who have attended schools in this state not registered by the Education Department, will present their credentials to the Director upon making application for admission. The extent of their preparation may be compared to the New York State standard by an inspection of the list of academic studies below. The applicant's credentials will be forwarded to and examined by the New York State Education Department. If the preparation is found to be equivalent to a four year high school course, as represented by the academic diploma issued by the Department, as above, and includ-

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*List of academic subjects, p. 54. Also, Syllabus for Secondary Schools 1905; Secondary Education Bulletin 27, pp. 10-15, New York State Education Department, Albany.

*College Entrance Examination Board, Dr. Thomas S. Fiske, Secretary, P. O. Sub-station 84, New York, N. Y.

ing advanced algebra and solid geometry, it will issue without examination the necessary credential admitting the candidate to matriculation in this Institution.

Notes on Matriculation.

If advanced algebra and solid geometry are not included in the accepted certificate, the candidate for admission will be matriculated as conditioned in these subjects. Such conditions may be removed by special examination in the Institution at the time of entrance. During their freshman year, however, students may take advanced algebra and solid geometry in special classes at the school; provided, that they have attained such advanced standing in other subjects as will warrant this procedure; and the condition may be removed upon passing the required examinations in these subjects.

Blank form of application for academic equivalent certificates, for admission to this School of Technology, will be forwarded upon application to the Director.

Matriculation, after September, 1906.

Hitherto 12 counts have been given for a year's work of 15 lessons a week—48 counts for a diploma. Hereafter 18 counts will be given for a year's work of 18 lessons a week—72 counts for a diploma, tested by Regents Examinations.

The proposed increased requirement of 18 lessons a week will go into operation in September, 1905, but is not to be retroactive. Therefore the number of counts required under the new scheme of values for an academic diploma will be as follows:

To June 1, 1906	48 counts
Between June 1, 1906, and June 1, 1907	63 counts
Between June 1, 1907, and June 1, 1908	66 counts
Between June 1, 1908, and June 1, 1909	69 counts
June 1, 1909, and thereafter	72 counts

All credits earned before June 1, 1906, will be recorded as hitherto. When these credits are applied to credentials issued subsequent to June 1, 1906, on New York State Education Department examinations, their value will be increased 25 per cent., since 12 counts under one scheme of values are exactly equal to 15 under the other.

The requirements for the academic diploma which is issued only to students taking the Department's preliminary and academic examinations, are as follows: English 13 credits, mathematics 10, history 10, science 10, elective 29. For the classical academic diploma: English 13 credits, mathematics 10, history 5, science 5, Latin 20, a second foreign language 15, elective 4. These new requirements go into effect June 1, 1909.

"One conclusion is beyond question: the constituency of an institution varies with its standard. A rising standard means a developing constituency. The harder the work, the greater the number of students and the better their quality. This is almost an educational axiom. It is always to be reckoned with. It means the best instructors, the best facilities. Where learning, exact and exhaustive, blends with the industries in shaping the material for discipline, training and instruction, thither the spirit of the age and the common ambition will send the potential master spirits of the coming day."—Charles Sumner Murkland, A.M., Ph.D., Commencement Address, 1902.

ACADEMIC SUBJECTS.*

Group I—Language and Literature.

ENGLISH

(4 First year English)
(3 Second year English)
3 Third year English
3 Fourth year English
2 English grammar
2 History of the English language and literature

ANCIENT

(5 First year Latin)
1 Latin grammar
1 Elementary Latin composition
3 Caesar
4 Cicero
4 Virgil
1 Latin composition
1 Translation of prose at sight
1 Translation of poetry at sight
(5 First year Greek)
1 Greek grammar
1 Elementary Greek composition
3 Anabasis
3 Iliad
1 Greek composition
1 Translation of prose at sight
1 Translation of Homer at sight

MODERN FOREIGN

(5 First year German)
5 Elementary German
5 Intermediate German
5 Advanced German
(5 First year French)
5 Elementary French
5 Intermediate French
5 Advanced French
(5 First year Spanish)
5 Elementary Spanish
5 Intermediate Spanish

Group II—Mathematics.

2 Advanced arithmetic
5 Elementary algebra
2 Intermediate algebra
3 Advanced algebra
5 Plane geometry
2 Solid geometry
2 Trigonometry

Group III—Science.

5 Physics
5 Chemistry
5 Biology
2½ Elementary botany
2½ Elementary zoology
2½ Physiology and hygienne
5 Advanced botany
5 Advanced zoology
5 Physical geography
3 Agriculture

Group IV—History and Social Science.

3 or 5 Ancient history
3 or 5 European history
3 or 5 English history
5 American history with civics
2 Civics
2 Economics

Group V—Business Subjects.

4 Elementary bookkeeping
3 Advanced bookkeeping
2 Business practice and technics
2 Business arithmetic
2 Commercial law
2 History of commerce
3 Commercial geography
2 Business correspondence
1 Business writing
3 Stenography (50 words)
3 Stenography (100 words)
2 Typewriting

Group VI—Other Subjects.

2 History and principles of education
3 Psychology and principles of education
3 Drawing
3 Advanced drawing
2 First year home science
2 Second year home science
2 First year shopwork
2 Second year shopwork

The numerals prefixed to the subjects in the above list indicate the number of lessons a week for a year and also the number of counts to be earned thereby.

*Syllabus for Secondary Schools 1905. Secondary Education Bulletin 27, pp. 11-12. New York State Education Department, Albany.

Admission to Advanced Standing.

Undergraduates from other institutions, to be admitted as regular students in the sophomore or junior class of any course, must first meet the academic requirements for matriculation of the corresponding freshman year of that class, page 53. Blank forms of application for academic equivalent certificates for admission to this Institution, will be forwarded upon request to the Director.

The candidate will then be required to pass satisfactory examinations in the subjects given at this Institution in the preceding year; or, to furnish satisfactory evidence of having completed the equivalent work of the earlier years by presenting certificates of the same or similar work done in other colleges or technical schools. These certificates must be clear and definite with regard to subjects taken, ground covered, length of course in weeks and periods per week; and, methods of instruction pursued, recitations, lectures, laboratory, etc., with standing in proficiency attained. Blank forms of application for admission to advanced standing will be forwarded upon request to the Director.

In determining the status of applicants for advanced standing the earlier work thus submitted will be measured on the semester hour basis, page 56, and compared to the standards and courses of this Institution, as set forth in the requirements for the degree, pages 57-9. The credit to be given such earlier work, and thence embodied in the recommendations of the Faculty for the degree, according to the rules of the University of the State of New York, can only be determined after the work of the applicant has been submitted to the Faculty through the report of the professor concerned.

The applicant is also required to file with the Director a certificate of honorable dismissal from the institution last attended.

Admission of Special Students.

Special students who furnish, by examination or certificate, satisfactory evidence of sufficient and thorough preparation will be admitted to such regular courses as they may be qualified to pursue to advantage. Special courses of study may be arranged subject to the approval of the Faculty.

Special students not attending another school or otherwise engaged in outside work, must register for at least ten semester hours, but are not allowed without permission of the Faculty to register for more than eighteen semester hours of class-room and practical work per week.

DEGREES AND CERTIFICATES.

Degrees. All candidates for graduation who satisfactorily complete the regular four year courses of study and the examinations required, and who have been recommended by the Trustees of this school to the Regents of the University of the State of New York for the degree of Bachelor of Science, receive from the University the degree of B.S., in the course pursued: namely, chemical, civil, electrical or mechanical engineering, or home economics. This degree is certified by a diploma bearing the seals and official signatures both of this institution and of the University of the State of New York.

Certificates. Upon the satisfactory completion of all required

work in the regular two year course in Home Economics, there will be awarded a certificate in this course signed by the Director and by the President and Secretary of the Board of Trustees.

REQUIREMENTS FOR GRADUATION.

Basis of Credit.

Credit toward graduation is given in the several courses on the following basis: One semester-hour credit is given for one lecture or recitation, per week, for a semester of eighteen weeks; or for a practice period of three hours per week for the same length of time.

The total work of the four years, as required for the baccalaureate degree, is equivalent to one hundred and forty-two semester hours; and, of the two years, as required by the certificate in Home Economics it is equivalent to sixty-eight semester hours.

To be entitled to graduate the candidate must have satisfactorily completed all of the prescribed and elective work of the given course, and will be required in addition to pass all final examinations which may be given on subjects relating particularly to the course.

No student can be recommended to the Trustees as a candidate for graduation till all dues to the school have been settled, and the accepted type-written copy of the thesis placed in the library of the institution.

Theses.

Candidates for graduation will be required to present a satisfactory thesis. It should embody the results of scientific work, experiment and investigation along the lines represented by their respective courses and deal in a competent manner with problems similar to those arising in professional work. The topic selected should be well within the power of the student to elaborate in the time allowed.

The title and completed thesis must be submitted to the head of that department from whose course the student is to graduate. The type-written copy of the thesis should be prepared according to the specifications for theses adopted by the Faculty. (See the Handbook.)

Schedules of Requirements for Graduation.

In the following schedules where the subtitle of each course is given it is followed (in parenthesis) by the name and number of the course of instruction under which its description will be found; thus, "Coal Analysis (Chemistry 25)" is described, with the days and hours assigned, under "Chemistry," course 25, which is "Coal Analysis."

If a number immediately follows any course, as "English 1," it implies that there is no subtitle; and its description is given under that title, in this case under "English."

The semester-hour credit of each course is given in the right-hand column. The usual abbreviations are used for the engineering courses of instruction: C. E., civil engineering; E. E., electrical engineering; M. E., mechanical engineering.

Requirements for the Baccalaureate Degree.

The following requirements for the first two years are common to the four courses leading respectively to the degree of Bachelor of Science in Chemical, Civil, Electrical and Mechanical Engineering:

Freshman Year.

I. Semester.	Semester hours per week	II. Semester.	Semester hours per week
English 1	2	English 2	2
French 1 or German 1	5	French 2 or German 2	5
Trigonometry (Math. 2)	4	Analytic Geometry (Math. 4)	2
Chemistry 1	4	Calculus (Math. 12)	2
Mechanical Drawing (Drawing 31)	2	Qualitative Analysis (Chemistry 2)	4
Woodworking (Shopwork 3)	1	Elem. of Eng'g Construction (M. E. 8)	2
		Woodturning (Shopwork 6)	1
	18		18

Sophomore Year.

French 3 or German 3	2	Economics 1	2
Calculus (Math. 5)	3	Differential Equations (Mechanics 3) Theoretical Mechanics (Mechanics 1)	5
Analytic Geometry (Math. 13)	2		
Physics 1	5	Physics 2	5
Physical Laboratory (Physics 21)	1	Physical Laboratory (Physics 22)	1
Descriptive Geometry (Drawing 33)	2	Elements of Mechanism (M. E. 11)	2
Surveying (C. E. 1)	1	Surveying (C. E. 2)	1
Forging (Shopwork 4, 5)	2	Machine Work (Shopwork 10)	2
	18		18

"That education is faulty which attempts to put into the hands of its devotees tools by which they may win such a measure of success as it lies in the power of each man to win, but does not put within the reach of every one so trained the fundamental knowledge which enables any man to understand the tools of his trade, which does not, moreover, enable him to dream the dreams and see the visions of the prophet, to mark out a large path, to see where it lies, and to see its influence on the lives of others and make them yield tribute to the achievement. This is success! For this the power of the prophet's vision is necessary. Such power rests only upon the foundation of thorough education. The student wonders at the very deep foundation being laid before he begins the study of its applications. If he be a true student and is to become a successful man, it is this foundation which in future will remain and form the basis of his power, remaining even after the whole superstructure has been swept away. Conditions change and methods change, and only scientific fundamentals remain. Power only comes to him who can build continuously while sweeping aside from his foundations the structures so fondly thought stable; and beginning anew, mount each time higher and higher with a more and more stable superstructure."—Frederic A. C. Perrine, D. Sc., Founder's Day Address, 1903.

Requirements for the Degree of Bachelor of Science in Chemical Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Econ. 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2)	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
D. C. Dynamos and Motors (E. E. 1)	3	Iron Analysis (Chemistry 24)	1
Electrical Laboratory (E. E. 21)	1	Metallurgy of Iron and Steel (Mining 5)	1
Heat Engines (M. E. 13)	4	Mineralogy (Mining 3)	3
Organic Chemistry (Chemistry 3)	4	Quantitative Analysis (Chemistry 20)	2
		Heat Engines (M. E. 13)	2
		Industrial Chemistry (Chemistry 4)	4
	18		18

Senior Year.

Laws of Operation and Contracts, (Economics 5, 6)	2	Engineering Economics (Economics 2)	1
Coal Analysis (Chemistry 25)	1	Power Plants (E. E. 11)	2
Water Analysis (Chemistry 23)	1	Assaying (Mining 26)	1
Cement Testing (Chemistry 28)	1	Organic Chemistry (Chemistry 27)	2
Advanced Quantitative Analysis	2	History of Chemistry (Chemistry 5)	1
Physical Chemistry (Physics 4)	2	Electro-Chemistry (Chemistry 6)	2
Electrical Laboratory (E. E. 23, 24)	1	Seminar	1
Electrical Machinery (E. E. 6)	4	Thesis	5
Seminar	1	Elective	2
Chemical Preparations	2		
	17		17

Civil Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Econ. 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2)	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
D. C. Dynamos and Motors (E. E. 1)	3	Iron Analysis (Chemistry 24)	1
Electrical Laboratory (E. E. 21)	1	Metallurgy of Iron and Steel (Mining 5)	1
Heat Engines (M. E. 13)	4	Mineralogy (Mining 3)	3
Kinematics (M. E. 1)	1	Heat Engines (M. E. 13)	2
†Railroads (C. E. 4, 25, 36)	3	Surveying (C. E. 2)	1
		†Geodesy (C. E. 3, 26)	3
		Electrical Laboratory (E. E. 22)	1
		Elective	1
	18		18

Senior Year.

Laws of Operation and Contracts, (Economics 5, 6,)	2	Engineering Economics (Economics 2)	1
Water Analysis (Chemistry 23)	1	Power Plants (E. E. 11)	2
Cement Testing (Chemistry 28)	1	Assaying (Mining 26)	1
Bridges and Roofs (C. E. 5)	3	Structural Design (C. E. 6)	3
Graphic Statics (C. E. 35)	2	*† Masonry and Foundations (C. E. 8) / Municipal Engineering (C. E. 11)	3
*†Municipal Engineering (C. E. 10)	3	Thesis	5
Mechanical Eng'g Lab'y (M. E. 23)	1	Elective	2
Gas and Oil Analysis, (Chemistry 21, 22)	1		
Mining (Mining 4)	2		
Elective	1		
	17		17

†Seniors and Juniors unite in these subjects. *Not given in 1906-1907.

Requirements for the Degree of Bachelor of Science in Electrical Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Econ. 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
D. C. Dynamos and Motors (E. E. 1)	3	Iron Analysis (Chemistry 24)	1
Electrical Laboratory (E. E. 21)	1	Metallurgy of Iron and Steel (Mining 5)	1
Heat Engines (M. E. 13)	4	Alternating Currents (E. E. 4)	3
Kinematics (M. E. 1)	1	Electrical Laboratory (E. E. 22)	1
Machine Drawing (Drawing 34)	2	Heat Engines (M. E. 13)	2
Gas and Oil Analysis (Chemistry 21, 22)	1	Machine Design (Drawing 36)	2
		Pattern Making (Shopwork 7)	1
		Foundry (Shopwork 9)	1
		Elective	1
	18		18

Senior Year.

Laws of Operations and Contracts, (Economics 5, 6,)	2	Engineering Economics (Economics 2)	1
Coal Analysis (Chemistry 25)	1	Electric Transmission (E. E. 8)	4
Electrical Machinery (E. E. 6)	4	Power Plants (E. E. 11)	2
Electrical Laboratory (E. E. 23, 24)	1	Gas Engines (M. E. 7)	1
Gas Engines (M. E. 7)	1	Mechanical Eng'g Lab'y (M. E. 23)	1
Steam Turbines (M. E. 15)	1	Thesis	5
Mechanical Eng'g Lab'y (M. E. 23)	1	Elective	3
Graphic Statics (C. E. 35)	2		
Mechanical Construction (Shopwork 12)	3		
Elective	1		
	17		17

Mechanical Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Econ. 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2)	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
D. C. Dynamos and Motors (E. E. 1)	3	Iron Analysis (Chemistry 24)	1
Electrical Laboratory (E. E. 21)	1	Metallurgy of Iron and Steel (Mining 5)	1
Heat Engines (M. E. 13)	4	Alternating Currents (E. E. 4)	3
Kinematics (M. E. 1)	1	Electrical Laboratory (E. E. 22)	1
Machine Drawing (Drawing 34)	2	Heat Engines (M. E. 13)	2
Gas and Oil Analysis (Chemistry 21, 22)	1	Machine Design (Drawing 36)	2
		Pattern Making (Shopwork 7)	1
		Foundry (Shopwork 9)	1
		Elective	1
	18		18

Senior Year.

Laws of Operation and Contracts (Economics 5, 6)	2	Engineering Economics (Economics 2)	1
Coal Analysis (Chemistry 25)	1	Structural Design (C. E. 6)	2
Advanced Testing Materials (M. E. 21)	1	Power Plants (E. E. 11)	2
Machine Design (Drawing 37)	2	Mech. Eng'g Conference (M. E. 16)	1
Steam Turbines (M. E. 15)	1	Mech. Eng'g. Laboratory (M. E. 23)	1
Mech. Eng'g. Laboratory (M. E. 23)	1	Gas Power Plants (M. E. 31)	1
Graphic Statics (C. E. 35)	2	Valve Gears (M. E. 2)	1
Mechanical Construction (Shopwork 12)	3	Thesis	5
Gas Engines (M. E. 7)	1	Elective	3
Elective	3		
	17		17

Requirements for the Degree of Bachelor of Science in Home Economics.

Freshman Year.

I. Semester.

	Semester hours per week.
English 1	2
French 1 or German 1	5
Trigonometry, (Math. 2)	4
Chemistry 1	4
Laundering, (Home Economics 2)	1
Plain Sewing (Home Economics 25)	2
	18

II. Semester.

	Semester hours per week.
English 2	2
French 2 or German 2	5
Analytic Geometry (Math. 4) / Calculus (Math. 12)	4
Qualitative Analysis (Chemistry 2)	4
Bacteriology (Home Economics 9)	2
Plain Sewing (Home Economics 25)	1
	18

Sophomore Year.

I. Semester.

French 3 or German 3	2
Physics 1	5
Quantitative Analysis (Chemistry 20)	2
Composition and Production of Foods, (Home Economics 4)	2
Physiology (Home Econ. 8)	2
Foods (Home Economics 21)	2
Mechanical Drawing (Drawing 31)	2
Elective	1
	18

II. Semester.

Economics 7	2
Physics 2	5
Quantitative Analysis (Chemistry 20)	2
Composition and Production of Foods, (Home Economics 4)	2
Hygiene (Home Econ. 8)	1
Foods (Home Economics 21)	3
Basketry (Home Economics 28)	2
Elective	1
	18

Junior Year.

I. Semester.

Sociology	1
English Literature	2
Organic Chemistry (Chemistry 3)	4
Water Analysis (Chemistry 23)	1
Domestic Architecture and Sanitation (Home Economics 5)	2
Textiles (Home Economics 1)	1
Home Nursing (Home Econ. 10)	1
Drafting and Dressmaking, (Home Economics 27)	2
Psychology	2
Electives	2
	18

II. Semester.

Economics 8	2
Modern History and Current Topics	2
Organic Chemical Analysis (Chem. 27)	2
Domestic Architecture and Sanitation (Home Econ. 5)	2
Heating and Ventilation (M. E. 6)	1
Textiles (Home Economics 1)	1
Household Economy (Home Econ. 6)	1
Drafting and Dressmaking, (Home Economics 27)	2
Pedagogy	2
Electives	3
	18

Senior Year.

I. Semester.

Chemical Food Analysis	4
Theory and Practice of Teaching, (Home Economics 7)	3
Dietetics (Home Economics 3)	1
Foods (Home Economics 22)	4
Elective	5
	17

II. Semester.

Chemical Food Analysis	4
Theory and Practice of Teaching, (Home Economics 7)	3
Dietetics (Home Economics 3)	1
Foods (Home Economics 22)	4
Thesis	5
	17

Requirements for the Certificate in Home Economics.

First Year.

I. Semester.

	Semester hours per week.
English 1	2
Chemistry 1	4
Composition and Production of Foods, (Home Economics 4)	2
Physiology (Home Econ. 8)	2
Laundering (Home Economics 2)	1
Foods (Home Economics 21)	2
Plain Sewing (Home Economics 25)	2
Psychology	2
	17

II. Semester.

	Semester hours per week.
English 2	2
Qualitative Analysis (Chemistry 2)	4
Composition and Production of Foods, (Home Economics 4)	2
Hygiene (Home Econ. 8)	1
Bacteriology (Home Economics 9)	2
Foods (Home Economics 21)	2
Plain Sewing (Home Economics 25)	2
Pedagogy	2
	17

Second Year.

Sociology	1
Organic Chemistry (Chemistry 3)	4
Textiles (Home Economics 1)	1
Theory and Practice of Teaching, (Home Economics 7)	3
Dietetics (Home Economics 3)	1
Home Nursing (Home Econ. 10)	1
Foods (Home Economics 22)	3
Handwork (Home Economics 26)	1
Electives: English Literature	2
Electives: French 1	2
Electives: German 1	2
Electives: Water Analysis	1
Electives: Thesis 1	1
Electives: Domestic Architecture	1
Electives: Economic Entomology	1
	17

Economics 7	2
Organic Chemical Analysis (Chem. 27)	2
Textiles (Home Economics 1)	1
Theory and Practice of Teaching, (Home Economics 7)	3
Dietetics (Home Economics 3)	1
Drafting and Dressmaking, (Home Economics 27)	2
Foods (Home Economics 22)	3
Thesis	1
Electives: Modern History	2
Electives: Economics 8	2
Electives: Domestic Architecture	1
Electives: Basketry	2
Electives: Household Economy	1
	17

DESCRIPTION OF THE COURSES OF INSTRUCTION.

The school year is divided into two semesters, eighteen weeks, including the time for the final examinations. The daily periods or "hours" for lectures, recitations and class-room instruction are of 55 minute intervals and each will probably require two hours of home preparation. The practice periods for instruction in laboratories, drafting rooms, shops and field work, consist of three actual hours.

Credit toward graduation is given in the several courses on the following basis: one semester-hour credit is given for one lecture or recitation, per week, for a semester of eighteen weeks; or for a practice period of three hours per week for the same length of time.

In the following description of the courses of instruction, they are arranged in alphabetical order and designated by the name of the department and the number of the particular course. Thus, the first course in Chemistry is known as "Chemistry 1." After the description of each course there is stated the prerequisite or requirement, if any, for admission to it.

The semesters,—I. or II.; days of the week,—M., T., W., Th., F., S.; hours of the day,—1, 2, 3, 4, 5, 6, 7,; and semester-hour credit (Arabic figure in parenthesis) are then noted; for example, "Chemistry 1, I.; W., F., 4; M., 5, 6, 7; S., 2, 3, 4; (4)." This indicates that the course in general chemistry is given during the first semester, by lectures and class-room work, on Wednesdays and Fridays at the fourth hour; and is accompanied by laboratory practice on Mondays during the fifth, sixth and seventh hours, and on Saturdays during the second third and fourth hours; and a credit of four semesters hours will be allowed on this course.

Courses given during a portion of a semester,—as Chemistry 21, I., first nine weeks; M., 5, 6, 7; (½)" are reduced to the standard semester-hour basis for credit. When a course extends through both semesters,—I. and II., the semester-hour credit given is that for one semester only.

Whenever the hour or time at which classes are held is not specified, it is subject to such arrangements as may be found necessary at the beginning of each semester.

The professor in charge of each department gives the instruction in the several courses announced for that department unless otherwise stated.

Courses of instruction which are not given during 1906-1907 are designated by numbers enclosed within brackets, thus [32].

The following abbreviations are used in referring to the prerequisites in the engineering departments of instruction: C. E., civil engineering; E. E., electrical engineering; M. E., mechanical engineering.

Electives. Courses preceded by an asterisk (*) are not required for graduation in any of the four year schedules, but are entirely elective. They are offered in the departments of Electrical Engineering, Economics, English, Mechanical Engineering, Modern Languages, Social Science and Education. Electives may be chosen from regular courses, subject to the approval of the Class officers, but are given only on condition that at least three students take the same. No extra

charge is made for any elective courses unless they are taken in excess of the total semester hours scheduled for the class in which the student may be registered for any one year.

CHEMISTRY.

Professor Williams.

1. **Chemistry.** Fundamental principles of the science, including study of nonmetallic and metallic elements, with particular attention to their industrial and commercial relations. Discussions upon the recent developments in chemical theory and practice serve to keep the student in touch with the rapid advances of modern chemistry.

Instruction is given by means of lectures, by assigned reference work in standard books of chemistry, and by recitations; all this being supplemented by intelligent work in the laboratory. Frequent examinations serve to make the student's knowledge of the subject definite and specific.

The work in general chemistry is taken up in the following order:

Non-metals. Matter, forces, chemical and physical changes, classification of elements, hydrogen and oxygen with their compounds, acids, salts and bases. Study of the individual members of the chlorin, sulfur, nitrogen and carbon groups, exercises in the solution of chemical problems.

Metals and Metallurgy. Metals and non-metals compared, the Periodic System as a basis for grouping the elements, study of the individual members of the potassium, calcium, aluminum, lead, iron, magnesium and platinum groups, and the common methods of extraction of the metals from their ores. I.; W., F., 4; T., 5, 6, 7; S., 2, 3, 4; (4).

2. **Qualitative Analysis.** While instruction in the metallic elements and their compounds is given by lectures and recitations, this course is chiefly devoted to practical work in the laboratory. A number of analyses of the more important minerals and metalic substances are made.

The work includes the determination of the various bases in both simple and compound solutions, together with the acid radicals. In addition to the analysis of solutions, practice in the use of the blowpipe and the other methods of dry analysis. Prerequisite, Chemistry 1. Lectures, recitations and laboratory work. II.; W., F., 4; M., 5, 6, 7; S., 2, 3, 4; (4).

3. **Organic Chemistry.** Study of fundamental principles of organic chemistry, including detailed consideration of the methane and benzene series of hydrocarbons, alcohols, ethers, aldehydes, ketons, fats and oils, saponification, starches, sugars, substitution products, aniline dyes, indigos and alkaloids. Special attention is paid to the chemical structure and methods of preparation of those compounds having practical industrial value. Prerequisite, Chemistry 1. Lectures, recitations and laboratory work. I.; M., W., S., 1; F., 1, 2; (4).

4. **Industrial Chemistry.** Study of the various technical methods used in the commercial manufacture of chemical products: sulphuric, hydrochloric and nitric acids, ammonia, potash and fertilizers, glass and pottery, lime and cement, paints, coal tar products, mineral oils, sugar starch, glucose and fermentation industries, textiles, paper,

leather, glue, etc. Instruction is given by lectures, assigned text-book work and laboratory practice. Prerequisite, Chemistry 1. II.; (4).

5. **History of Chemistry.** Assigned reference work and the preparation of papers and biographical sketches of noted chemists with their particular achievements. II.; (1).

6. **Electro-Chemistry.** Study of electro-chemical constants, chemical analyses by electrolysis, construction and operation of various types of electrical furnaces and their commercial products. Reference and laboratory work. II.; Arrange time; (2).

20. **Quantitative Analysis.** Quantitative separation and determination of the more important bases and acids by gravimetric, volumetric and electrolytic methods, including calibration of glass ware and other apparatus. After thorough mastery of general principles of quantitative analysis, choice of practical work is allowed, adapted to the needs of the individual student. Prerequisite, Chemistry 2. Required of students specializing in Chemistry and Home Economics. Lectures and laboratory. I. and II.; (2).

21. **Gas Analysis.** Proper selection of samples of flue and illuminating gases, determination of constituents, deductions from the results of anlysis. Given with the standard apparatus of Hempel, Orsat, Winkler, Lunge, etc. Calculation of heating value of fuel gases. Prerequisite, Chemistry 2. Laboratory work. I., first nine weeks; W., 5, 6, 7; (½).

22. **Oil Analysis.** Determination of the composition and purity of burning and lubricating oils, and the adaptability of various oils to particular requirements. Prerequisite, Chemistry 2. Lectures and laboratory. I., last nine weeks; W., 5, 6, 7; (½).

23. **Water Analysis.** This work includes the sanitary analysis of samples of drinking water, together with the microscopic examination of the same and the determination of the fitness of water to be used in boilers. In connection with the latter, chemical analyses are made of boiler scale. Accompanying the laboratory work in water analysis, lectures are given upon the interpretation of the results of analysis, on the various methods for the purification and softening of water supplis, and the disposal of sewage. Prerequisite, Chemistry 2. Lectures and laboratory. I.; M., 5, 6, 7; (1).

24. **Iron Analysis.** Technical methods for the determination of percentage of iron in ores, of silica, sulfur, phosphorus, combined and graphite carbon in iron and steel. In this course, attention also is given to the microscopic examination of iron and steel, accompanied by work in the selection and polishing of specimens, the microscopic examination and identification of constituents, and the making of microphotographs. Prerequisite, Chemistry 2. Laboratory course. II.; Tu., 5, 6, 7; (1).

25. **Coal Analysis.**

(a) Approximate Analysis. Collection of average sample, determination of percentage of moisture, volatile matter, fixed carbon and ash.

(b) Organic Chemical Analysis. Determination of nitrogen, hydrogen, oxygen, sulfur, carbon and ash by the ordinary combustion methods. Deduction of theoretical heat value of coal and other fuels from the results of chemical analysis.

(c) Direct determination of heat value of fuels by com-

bustion in Mahler bomb calorimeter. This work serves as a valuable check upon the theoretical computations from the results of chemical analyses. Prerequisite, Chemistry 2. Laboratory course. I.; Th., 5, 6, 7; (1).

27. **Organic Chemical Analysis.** Quantitative determination of carbon, hydrogen, oxygen, sulfur and nitrogen by the ordinary methods of ultimate analysis; calculation of chemical formula from results of analysis and molecular weight determinations; practical applications in the analysis of various food products including milk, flours, starches, sugars, baking powders, etc. Prerequisites, Chemistry 2, 3. Laboratory. II.; Th., 1, 2, 3; F., 1, 2, 3; (2).

28. **Cement Testing.** Discussions upon methods of manufacture and uses of various types of cement. Chemical analysis. Laboratory tests of tensile strength, fineness, specific gravity, time of setting, tendency to checking and cracking, etc. Special investigation of the strength of reinforced concrete and structural forms of concrete steel. Lectures and laboratory work. I.; (1).

CIVIL ENGINEERING.

Professor Derr.

1. **Surveying.** General principles and fundamental operations; instruments; the declination of the magnetic needle; obstacles in angular surveying; laying out, parting off and dividing up land; United States land surveys. Prerequisites, Math. 2, Drawing 31. Lectures and problems, field work, drafting and computations. I.; Th., 5, 6, 7; (1).

2. **Surveying.** A continuation of C. E. 1. Leveling, higher surveying; adjustments of instruments; topographic and exploratory surveying; plane and tachymetric surveying. Prerequisite, C. E. I., II.; Th., 5, 6, 7; (1).

5. **Bridges and Roofs.** Computation of stresses in bridge and roof trusses; highway and railway bridge trusses; deflection and internal work. Prerequisite, Mechanics 2. Recitations, computations and drafting. I.; T., Th., 4; (3).

6. **Structural Design.** Principles of economic design; design of plate girder bridge, pin bridge, riveted bridge; class-room designs; continuous bridges, draw bridges, cantilever bridges, suspension bridges arches; building construction. Prerequisite, C. E. 5. Lectures, problems, computations and drafting. II.; M., 5, 6, 7; (3).

[8.] **Masonry and Foundations.** Building stone, retaining and reservoir walls and dams, arches; mechanics of masonry construction; foundations on land and water; coffer dams, caisson and crib dams; pneumatic caissons. Prerequisite, Mechanics 3. Lectures and recitations. II.; T., F., S., 4; (1½).

[10.] **Municipal Engineering.** Construction and maintenance of city streets and country roads; study of pavements and paving materials; construction of sewers; sewage disposal and destruction: house plumbing. Prerequisites, C. E. 2, Mechanics 3. I.; M., W., F., 4; (3).

[11.] **Municipal Engineering.** A continuation of C. E. 10. Hydrography; surface and underground waters; reservoirs; water supply; methods of filtration and distribution. Prerequisite, C. E. 10. II.; Th., F., S., 4; (1½).

21. City Surveying. Precise methods of measuring distances and angles; city surveys; mining survey methods. Prerequisite, C. E. 2. Recitations, field work, drafting and computations. I., first twelve weeks; Saturday, 9 hours; (2).

25. Field Practice. Given in connection with C. E. 4. I., first nine weeks; Saturday, 9 hours.

26. Field Practice. Given in connection with C. E. 3. II.; last nine weeks; Saturday, 6 hours.

35. Graphic Statics. General principles of the force and equilibrium polygons; determination of reactions and stresses of roof and bridge trusses; center of gravity and moment of inertia; the course is intended to supplement Civil Engineering 5, Bridges and Roofs. Prerequisites, Drawing 31 and Mathematics 2. I.; W., 5, 6, 7; (2).

36. Drafting. Given in connection with C. E. 4, 25. I.

DRAWING AND DESIGN.

31. Mechanical Drawing. The use of instruments; geometric drawing; elementary mechanical drawing; the foundation for subsequent work in drawing and design. Prerequisite, plane geometry. Lectures and drawing. I.; T., Th., 3, 4; (2). Professor Willhofft.

32. Advanced Mechanical Drawing. Isometric and other methods of projection than the orthographic; linear perspective; shades and shadows; applications in engineering and building construction, structural and architectural work, conventional details and symbols; color work. II.; arrange time; (2). Professor Willhofft.

33. Descriptive Geometry. Elementary principles; problems relating to points, lines, planes and solids; intersections of planes. Prerequisite, Drawing 31. Drawing and problems. I.; W., 2; F., 5, 6, 7; (2). ProfessorGraffam.

34. Machine Drawing. Freehand detail sketches of different parts of a given machine; working drawings; tracing and blue printing; assembly drawings made from details. Prerequisite, Drawing 31. I.; M., F., 5, 6, 7; (2). Professor Willhofft.

35. Lettering, Tinting and Shading. Freehand lettering for working drawings, maps, etc. Rendering in water color, sepia and India ink. I., last six weeks; arrange time; 9 hours; (1). Professor Derr.

36. Machine Design. Freehand detail drawings; working drawings, including tracing and assembly drawings; also design of some part of a machine or of an engine from specifications, by the use of hand books. Prerequisite, Drawing 34. II.; W., 3, 4; Th., 5, 6, 7; (2) Professor Willhofft.

37. Machine Design. Study of the principles underlying the designing of machinery, with application to the complete designing of some unit; comprising a calculation of all the stresses and the necessary distribution and arrangement of metal to withstand them; design of fly-wheels, shafting, couplings, pulleys, etc. Prerequisites, Drawing 36, Mechanics 2. I.; (2). Professor Willhofft.

41. Technical Photography. A study of apparatus, optics of photography, exposure, developers, fixers, dry plates, developing papers printing-out papers, toning, blue-print processes, VanDyke solar pro-

cess, lantern slide making, progress photographs of engineering structures, etc. Lectures and laboratory practice. Prerequisites, Chemistry 1, Physics1. II.; arrange time; (1). Professor Derr.

ECONOMICS.

For reference to details of the courses offered there have been grouped under this general heading the discussions of legal and customary regulations bearing upon the engineering construction and professional practice, as outlined in the following courses: 2, 5 and 6. In these courses the study of the text is accompanied with lectures and collateral reading, the preparation of papers and reports.

1. **Economics.** Principles of economics and outlines of economic theory with reference to their applications in modern business, commeree and trade; capital and labor and their organization. Lectures, recitations, reports. II.; T., Th., 4; (2). Director Aldrich.

2. **Engineering Economics.** Specifications, estimates and appraisals; economics of the development and execution of engineering projects; employment of engineers and the ethics of engineering practice. Prerequisite, Economics 6. Texts, Johnson, Wait. II., first nine weeks; W., 3; F., 1; (1). Director Aldrich.

3. **Economics of Industry.** An economic study of resources and their utilization, industries and their development, and of machinery and transportation. Prerequisite, Economics 1. Lectures, reports. I.; Th., 1; (1). Director Aldrich.

4. **Economics of Manufactures.** A study of modern methods of workshop production, from the design to the finished product; details of standardization, duplication and interchangeability of machine elements; shop accounting, systems, and organization for economic production and distribution. Lectures and reports. II.; M., 4; (1). Professor Graffam.

5. **Laws of Operations.** A study of the law of operations preliminary to construction in engineering; discussion of the rights and privileges incident to the ownership of real property, water rights boundaries and power developments; and the rights of way for railways. Prerequisite, Economics 3. Text, Wait. I., first nine weeks; W., 3; F., 1; (1). Director Aldrich.

6. **Laws of Contracts.** A study of the laws of construction as related to contracts, bids and bidders. Prerequisite, Economics 5. Texts, Johnson, Wait. I., last nine weeks; W., 3; F., 1; (1). Director Aldrich.

7. **Elements of Economics.** A general course intended to fit students to think intelligently along economic lines. Seligman and Fetter used as textbooks, with occasional references to other works. Discussions, recitations, lectures and reports. II.; T., 3; W., 5; (2). Professor Michel.

8. **Advanced Economics.** The consideration of a number of economic problems is taken up, some of them by the class as a whole, and some by the different students working independently. The students are assisted in their investigations by a small but carefully selected reference library. Prerequisite, Economics 7. Discussions, lectures and reports. II.; (1) or (2). Professor Michel.

9. Railway Economics. A study of some of the engineering and economic features of traction and transportation problems, on steam and electric railroads. Prerequisite, Economics 3. Lectures and reports. II.; T., Th., 3; (1). Director Aldrich.

ELECTRICAL ENGINEERING.

Professor Brackett.

1-2. Direct Current, Dynamos and Motors. The Theory, construction and operation of continuous current generators and motors. Prerequisite, Physics 2. Lectures and recitations. I.; M., W., F., 2; (3).

3. *Telegraphy and Telephony. Methods of land and submarine telegraphy; the theory of the telephone; systems and instruments used in telephone engineering. Laboratory work in capacity and induction measurements, and the experimental determination of the properties of lines and cables. An elective course offered to any class of senior electrical students that may desire work in this special line. Prerequisites, E. E. 1, 4. Lectures. II.; Tu.., Th., 2; (2).

4. Alternating Currents. Study of the theory of alternating currents by graphical and analytical methods. Inductance, capacity, impedance, etc. Methods of computation and measurement. Prerequisite, E. E. 1. Recitations and problems. II.; M., W., F., 2; (3).

6. Electrical Machinery. Course on the theory, construction, regulation and operation of single and polyphase generators, motors, transformers and rotary converters; and the comparative design of direct current and alternating current machinery. Prerequisite E. E. 4. I.; M., T., Th., F., 4; (4).

7. *Electrical Distribution. The methods for economical distribution of electrical energy for light and power purposes; insurance rules and regulations. Prerequisite, E. E. 4. Lectures and problems. I.; W., 4; (1).

8. Electric Transmission. Alternating-current transmission of power, characteristics and properties of transmission lines, construction, protection, management; economics of design and regulation; single and polyphase systems; high-potential and long-distance applications. Prerequisite, E. E. 6. Lectures and problems. II.; M., Tu., Th., F., 4; (4).

9. *Electric Lighting. Principles of illumination. Manufacture and use of incandescent and arc lamps. Principles of meters with methods of use and systems. An elective course to any class of senior electrical students that may desire such special work. Prerequisite, E. E. 6. Lectures. II.; Th., 2; (1).

11. Power Plants. Economic theory of location of central stations; selection, subdivision into units, and arrangement of installation of prime movers, generators and accessories. Prerequisites, Mechanics 3, M. E. 13. Lectures, reports and designs. II., first nine weeks; T., Th., 3; F., 5, 6, 7; (2). Director Aldrich.

21. Electrical Engineering Laboratory. Study of the methods and the experimental determination of resistance, inductance, capacity, conductivity, electromotive force, current strengths, the magnetic properties of iron and steel, and voltmeter and ammeter calibration. Prerequisites, Physics 22. I.; Th., 5, 6, 7; (1).

22. Electrical Engineering Laboratory. Methods of testing and an experimental study of the characteristics and properties of direct-current generators and motors. Prerequisites, E. E. 2, 21. II.; M., 5, 6, 7; (1).

23. Electrical Engineering Laboratory. Experimental study of alternating-current generators and motors and transformers, their efficiency, regulation, etc. Prerequisites, E. E. 6, 22. I.; F., 5, 6, 7; (1).

24. Photometric Laboratory. Experimental study by photometric methods of intensity and distribution of light, from electric lamps, arc, and incandescent. Effect of shades on intensity and distribution. Life and efficiency tests. Prerequisite, E. E. 21. I.; F., 5, 6, 7; (1).

25. *Special Electrical Engineering Laboratory. Additional work in any of the above lines or in some entirely different line, as may be elected and satisfactorily arranged at the time. Prerequisites, E. E. 4, 22. I.; (1).

31. *Electrical Design. Application of the theory of direct and alternating currents to the design of electrical apparatus. Prerequisites, E. E. 2, 6. Lectures and drafting. I.; (1).

32. Junior Electrical Design. A special course, elective for juniors, in the design of direct current machinery. Problems and drafting Prerequisite, E. E. 1-2. II.; arrange time; (1).

ENGLISH.

Professor Michel.

The Faculty has adopted the following regulation concerning English work: "Students' papers of all kinds shall be scrutinized for English, and no student markedly deficient in English shall be granted a degree." Students are trained to express their ideas in clear, forcible language adapted to professional needs. Great stress is laid upon the correction of errors in the student's own writing, development of style being sought largely by means of individual criticism.

1. English. Theme writing with especial attention to descriptive and narrative composition, together with constant attention to the correct use of English in every day speech. All written work is returned and made the basis of individual criticism. I.; M., 4; W., 2; (2).

2. English. The work of the first semester continued, together with practice in the construction of the essay, from the gathering of the material to the finished product. The second part of the semester will be more or less devoted to Science of Rhetoric. During the semester the class will also read and discuss some one classic, both from the standpoint of style and from that of thought. Prerequisite, English 1. II.; M., 4; W., 2; (2).

3. *English Literature. In the Junior year, students in whose course it is not otherwise required may elect one or two semester hours of work in English Literature. I.; (1) or (2).

HISTORY.

Professor Michel.

1. ***Modern History and Current Topics.** This course is chiefly devoted to the serious study and aggressive discussion of vital questions—social, economic and political—so as to keep in touch with present movements. No textbook is used, but standard magazine and newspaper articles, important news of the week and the month, and news that bear upon the progress of the world are made the basis for study, investigation and discussion. II.; (2).

2. ***History and Philosophy.** The chief aim of this course will consist in tracing our modern doctrines and thoughts to their sources by investigating old and modern philosophic doctrines with regard to psychology, ethics, cosmology, theology, metaphysics, biology, anthropology, political government and moral science (practical philosophy), scientific doctrines, etc. The work will be based on "Turner's History of Philosophy" with parallel readings, comparisons, study and discussion of extracts selected from standard works and essays. II.; (1) or (2).

HOME ECONOMICS.

Miss Clarke, Associates and Assistants.

1. **Textiles.** Arranged to give the student a thorough knowledge of fibres with the development of the processes of their manufacture. Special attention is paid to application in the school. Lectures and practical work. I. and II.; (1).

2. **Laundering.** Every variety of fabric is laundered and the theory and practice of the subject are carefully considered. Lectures and practical work. I.; (1).

3. **Dietetics.** A study of the dietaries of different peoples, dietaries for children and invalids, computation of food values and the planning of menus. Lectures and recitations. I. and II.; (1).

4. **Composition and Production of Foods.** This course is closely correlated with Course 21, consisting of a study of the underlying food principles, with the manufacture and production of food materials. Lectures, recitations, and readings. I. and II.; (2).

5. **Domestic Architecture and Sanitation.** The following subjects will be considered: house sites, construction, plumbing, lighting, heating and ventilation. Lectures and recitations. I. and II.; (1). Professor Willhofft.

6. **Household Economy.** The economics of the household is taken up by considering such topics as the cost of living; division of income; household accounts; domestic service; furnishing and care of the home. Lectures, papers, and required readings. II.; (1).

7. **Theory and Practice of Teaching Home Economics.** This course is designed to present methods of teaching home economics in elementary and secondary schools, courses of study are discussed, lessons planned, equipment studied; and each student is required to teach under criticism. Lectures, conferences, and practical work. I. and II.; (3).

8. **Physiology and Hygiene.** This course is arranged to give a thorough, practical knowledge of the human body and to teach per-

sonal responsibility in the care and improvement of health. Lectures, laboratory work, and recitations. I.; (2); and II.; (1).

9. **Bacteriology.** This course is designed to give the students a good working knowledge of general bacteriology with special problems in household bacteriology and pathogenic forms found in food supplies. Lectures and laboratory work. II.; (2).

10. **Home Nursing.** A study of some simple diseases and their prevention; the care of patients; invalid dietaries; and first aid to the injured is made. Lectures and recitations. I.; (1).

21. **Foods.** A study of the fundamental principles and processes of cookery applied to the different foods according to their composition; special attention is paid to such dishes as are adapted to school work. Lectures and Laboratory work. I. and II.; (2).

22. **Foods.** (Advanced course). This is a continuation of course 21 and takes up more elaborate cookery; preservation of foods; invalid cookery; planning, cooking and serving of meals; a waitress's course and marketing. Lectures, recitations, and laboratory work. I. and II.; (3).

23. ***Economic Entomology.** A study of the more important household insect pests, including the use of insecticides and preventive remedies. Insect anatomy, metamorphosis, habits and classification. Laboratory work and assigned reading. I.; (1). Professor Derr.

25. **Plain Sewing.** A study of the principles of plain needlework with their application in various articles; special instruction is given in the methods of adapting the work to schools. Practical work and conferences. I. and II.; (2).

26. **Handwork.** Special types of handwork suitable for elementary grades are discussed and made. Paper folding, cardboard work, knotting, needlework, beading, knitting and crocheting. Laboratory work and discussions. I.; (1).

27. **Drafting and Dressmaking.** This course consists of drafting from simple measurements, the taking of these measurements accurately and the making of garments. Practical work and conferences. II.; (2).

28. **Basketry.** Instruction in cord work, raffia, splint and reeds, applied to such objects as are adapted to the work of children. Practical work. II.; (2).

MATHEMATICS.

Professor Derr.

The instruction in this department is designed, primarily, to meet the needs of engineering students. Particular attention is given to the practical applications to surveying, physics and engineering. These subjects are presented with such rigor of treatment, however, that the work done will serve as a sufficient foundation for the continuation of the study of applied mathematics.

2. **Trigonometry.** Fundamental theorems and solution of triangles; DeMoivre's theorem; Euler's exponential values; hyperbolic functions. Spherical triangles, their solution and practical application. Prerequisites, solid geometry and advanced algebra. M., T., Th., F.,2; (4).

4. Analytic Geometry. Co-ordinates, the straight line, change of axes, anharmonic ratios, involution, the circle, the parabola, the ellipse, the hyperbola, polar equation of a conic. Prerequisite, Math. 2. II.; M., T., 2; (2).

5. Calculus. The study of the calculus, begun in Math. 12, is here continued. Successive differentiation, indeterminate forms, maxima and minima and functions of a single variable, expansion of functions, functions of two or more variables, applications to geometry, including curve tracing. Integration of rational and irrational fractions, trigonometric and exponential functions; multiple integrals; mean values; approximate integration; integration by means or series, and the measurement of areas; integral curves. Prerequisites, Math. 4 and 12. I.; W., Th., F., 1; (3).

8. Method of Least Squares. This subject is given as an introduction to geodesy; see C. E. 3.

12. Calculus. Fundamental principles, differentiation of the elementary forms, successive differentiation, expansion of functions, rates and differentials, partial differentiation, tangents and normals; derivation of an arc, area, volume and surface of revolution, general principles of integration; integration as a summation; geometric applications; successive integration. Prerequisite, Math 2. II.; Th., F., 2; (2).

13. Analytic Geometry. A continuation of Math. 4. Systems of conics, higher plane curves, envelopes and miscellaneous propositions. Co-ordinates, the plane, surfaces of the second degree, conicoids; surfaces in general. Prerequisite, Math. 12. I.; M., T., 1; (2).

MECHANICAL ENGINEERING.

Professor Willhofft.

1. Kinematics. Laws of motion; combinations of pure mechanism; toothed and belt gearing; forms of teeth of wheels; rolling and sliding contact; link work. Prerequisites, Drawing 33, M. E. 11. Lectures, recitations and drawing. I.; (1).

2. Valve Gears. General theory of slide valve and link motions, with practical application to designing valve mechanisms; the application of the Zeuner diagram to the principal automatic and radial gears and to the slide valve. Prerequisite, M. E. 1. Lectures, recitations and drawing. II.; (1).

6. *Heating and Ventilation. The general principles underlying the design of the various systems of heating and ventilation in common use; loss of heat from buildings and the heat given off from radiating surfaces; problems in proportioning ventilating ducts, etc.; mechanical details of different systems. Lectures and recitations. Arrange time.

7. Gas Engines. A study of internal combustion motors; historical development; construction of modern engines; theory of combustion; fuels, liquid and gaseous, and their adaptation to use in gas engines; gas producers; cycles and phases, and efficiency of cycles; properties of explosive mixtures; ignition, governing, carburization, carburetors and cylinder cooling; mechanical design of parts. Prerequisite, M. E. 13. I. and II.; (1).

8. Elements of Engineering Construction. Description and general principles of engines and boilers; the use and reasons for using

various machines and parts of machines; details of cylinders, engine valves, etc.; the description and use of unions, valves, gages, pipe fittings and other elements of engineering construction; practice in the use of an engineering vocabulary; course is supplemented by freehand sketches of various parts of engines, etc. Lectures and recitations. II.; T., Th., 3, 4; (2).

11. Elements of Mechanism. A study of theoretical mechanism; an examination into the various contrivances and arrangements of parts in machinery whereby motion is set up and modified; the transmission of force by the same. Prerequisite, M. E. 8. Lectures and recitations. II.; M., F., 4; (2).

13. Heat Engines. A study of the theory and mechanism of all forms of heat engines; steam engines, reciprocating, rotary and turbines; steam boilers and accessories; internal combustion motors; air and vapor engines; air compressors, refrigerating machinery. Technical thermodynamics and practice in the use of the Entropy-Temperature method of analysis. Lectures, conferences and problems; also, visits to shops, factories and power stations. Prerequisites, Physics 2, Mechanics 5. I.; (4); and II.; (2).

15. Steam Turbines. A study of the principles involved in the design of the steam turbine; e. g., the flow of steam through nozzles and blade channels; the choice of peripheral velocities, angles and steam velocities; work lost in friction, etc.; a discussion of the construction of the most important parts; the regulation; the adaptation of the steam turbine to the various purposes, as power plant practice. Prerequisite, M. E. 13. I.; F., 2; (1).

16. Conference. Discussion of current engineering topics and technical literature. II.; (1).

20. Experimental Mechanics. Methods of measuring power; determination of power used by different machines; losses of power in transmission; determination of belt friction; the use of planimeters, slide-rules, etc. Experiments on tensile strength of iron, steel and other constructive materials; compression strength of cast iron, and of timber; transverse tests of steel and wooden beams and cast-iron bars; torsional tests of steel and iron shafting; a course to accompany Mechanics 2 and 4, and Chemistry 24. I. and II.; (1).

21. Advanced Testing Materials. Special mechanical and physical tests of bronzes, alloys and anti-friction metals, including micrographic examinations and study of structure; methods of steel reinforcement of structural concrete work; road materials and properties, and comparative tests for valuation and efficiency; assignment of individual problems and projects for investigation, tests and reports. Prerequisite, M. E. 20, Mechanics 2. II.; (1).

23. Mechanical Engineering Laboratory. Tests of steam engines, condensers and boilers; indicator and brake methods of measuring power; standardization of apparatus. Tests of engines and complete power plants in the vicinity. Efficiency tests of steam and air pumps, injectors, ejectors, gas engines, ventilating apparatus; radiation and pipe covering tests; steam flow; hydraulic measurements; tests of lubricants, etc. Prerequisite, M. E. 20. I. and II.; S., 1, 2, 3; (1).

31. Gas Power Plants. Choice of source of motive powers for given project; economics of gas power development, management and operation; apparatus and machinery in use in modern gas power

plants, gas producers and accessories, scrubbers, cleaners, vaporizers, etc.; fuels and processes; design, specification, bill of material, tracings and blue prints for project. Prerequisite, M. E. 7. II.; (1).

MECHANICS.

1. **Theoretical Mechanics.** Statics of material points, rigid bodies, flexible cords; centre of gravity; rectilinear, curvilinear motion; moment of inertia; dynamics of rigid bodies, work ,energy, power and friction. Applications to engineering problems. Prerequisites, Mechanics 5, Physics 1. Lectures, recitations and problems. II.; last nine weeks; M., T., W., Th., F., 2; (2½). Professor Willhofft.

2. **Applied Mechanics.** Elementary stresses and strains, principles, laws and factors; theory of flexure and applications in engineering construction; analytical and graphical methods; materials of engineering. Prerequisite, Mechanics 1. Accompanied by laboratory work in testing materials. M. E. 20. Lectures, recitations and problems. I.; M., T., W., 1; (3). Director Aldrich.

3. **Hydraulics.** Hydrostatics and theoretical hydraulics; study of flow through orifices, tubes, pipes, over weirs, in conduits, canals and rivers; applications in engineering, water power plants and developments. Prerequisite, Mechanics 1. Lectures, recitations and problems. II.; M., W., F., 1; (3). Professor Derr.

4. **Theoretical Mechanics.** A continuation of Mechanics 1, accompanied by course in experimental mechanics and power measurements. M. E. 20. I.; F., 1; (1). Professor Willhofft.

5. **Differential Equations.** Formation of a differential equation; equation of the first order; singular solutions; linear and exact differential equations; equations of particular forms; integration in series; equations of the second order; equations involving more than two variables; partial differential equations; special forms of differential equations; applications to geometry, mechanics and physics. Prerequisite, Mathematics 5. Text, Murray. II.; first nine weeks; M., T., W., Th., F., 2; (2½). Professor Willhofft.

MINING.

3. **Mineralogy.** Crystallography, occurrence, chemical and physical properties, and means of detection of the principal minerals including the native elements, sulfids, chlorids, fluorids, oxids, carbonates, silicates, phosphates. Especial attention is paid to minerals and ores of commercial value. Prerequisite, Chemistry 2. Recitations and laboratory. II.; W., Th.., 3; Tu., 5, 6, 7; (3). Professor Williams

4. **Mining.** Methods of mining, hoisting, pumping, ventilation, illumination, hygienic conditions; shafts, sinking in running ground. timbering, boring, breaking ground, blasting, drills and drilling, the compression of air, and mine examination. Prerequisites, Chemistry 4, Mechanics 2. Lectures and recitations. I.; (2). Professor Derr.

5. **Metallurgy of Iron and Steel.** Study of the types and geographical distribution of the various iron ores of the United States, specifications for and grading of ores, with current market prices of same; construction and operation of the blast furnace, grading of pig iron and valuation from market quotations, manufacture of wrought iron and

steel, Bessemer and Open Hearth, acid and basic; constituents and manipulation of self-hardened tool steels. Lectures and assigned papers. II.; M., 3; (1). Professor Williams.

26. **Assaying.** Practice in methods of both wet and dry assays of ores of commercial importance such as gold, silver, copper, lead, zinc, etc. Prerequisite, Chemistry 4. Laboratory courses. II.; Th., 5, 6, 7; (1). Professor Williams.

MODERN LANGUAGES.

Professor Michel.

In these courses no attention is given to composition. The purpose is to enable the student to avail himself of French and German works relating to his profession, and to give him the ability to read these languages with such ease that it will be a source of pleasure and usefulness to him thoughout life. Especial attention is given to readings in pure and applied science, while short works of the best authors are also read. However, the classes will be so conducted as to enable the student to carry on every day conversation. Every opportunity is sought to arouse an interest in the life of the French and German peoples.

Students on entering offering one or two years' creditable academic work, in either language, may be exempt from one or two semesters' language work, respectively; the time to be devoted to technical or other work, chosen from the regular, or elective courses offered in this Institution.

1. **French.** Fraser and Squair's grammar; fairly easy texts of modern French prose, sight reading and translation at hearing. I.; M., W., F., 3; S., 1; (5).

2. **French.** Herdler's Scientific French Reader, one or two modern French dramas or stories, current scientific periodicals; sight reading of fairly difficult Modern French prose. Prerequisite, French 1. II.; M., T., W., Th., F., 1; (5).

3. **French.** A continuation of the method of study followed in French 2. Prerequisites, French 1 and 2. I.; M., Th., 2; (2).

1. **German.** Joynes-Meissner's grammar; easy texts of modern German prose, sight reading and translation at hearing. I.; M., T., W., Th., F., 1; (5).

2. **German.** Hodge's Scientific German, Prehn's Journalistic German, one or two modern dramas or stories; scientific periodicals; sight reading of fairly difficult German; Joynes-Meissner's grammar. Prerequisite, German 1. II.; M., W., F., 3; S., 1; (5).

3. **German.** A continuation of the method of study followed in German 2. Prerequisites, German 1 and 2. I.; T., F,. 2; (2).

***Modern Language Electives.** Students who have the necessary preparation may, in the junior and senior years, elect one or two semester hours of French or German technical reading. This work will be individual, each student being expected to read along the line of his special course. Spanish may also be offered as an elective.

PHYSICS.

Professor Brackett.

1. **Physics.** Designed to lay a foundation for the student's future work in the various branches of engineering. Much attention is given to correct and exact conceptions of the various phenomena studied and to a clear understanding of the units employed in measurements and in computations. The mathematical treatment of physical questions and the intelligent solution of examples are made fundamentally important. Subjects for first semester, Mechanics and Heat. Prerequisite, Mathematics 12. I.; M., T., W., Th., F., 3; (5).

2. **Physics.** A continuation of Physics 1. Sound, Light and Electricity. Prerequisite, Physics 1. Lectures and recitations. II.; M., T., W., Th., F., 3; (5).

4. **Physical Chemistry.** A course in the mathematical theory of physical chemistry, treating the subject from the standpoint of energy transformations and employing the methods of the calculus. Lectures and problems. I.; T., Th., 2; (2).

21. **Physical Laboratory.** A course to illustrate the more important physical laws. The work is quantitative in its nature and includes the use of physical measuring instruments, methods of determining physical constants and experimental work in Mechanics and Heat. Much attention is given to sources of error, and the estimation of the probable accuracy of results. Prerequisite, Mathematics 12. I.; M., or T., 5, 6, 7; (1).

22. **Physical Laboratory.** A continuation of Course 21, and including work in Sound, Electricity, Magnetism and Optics. Prerequisites, Physics 1 and 21. II.; M., or T., 5, 6, 7; (1).

SHOPWORK.

Professor Graffam.

1. **Sloyd.** Elementary selected sloyd exercises in soft and hard woods, from students' working drawings, using knife, saw, chisel, gouge, and carving tools. I. and II.; (1). Mr. Littell.

2. **Sloyd.** Advanced work in sloyd from students' working drawings, using plane, saw, etc,, in gauging, fitting, framing and joinery work; elementary wood turning, between centres and with chuck and face plate, of simple geometric and ornamental forms. I. and II.; (2). Mr. Littell.

3. **Woodworking.** Bench work in wood; sawing, planing, gauging, chiseling, boring, mortising, dovetailing, fitting and joinery; construction, care and use of tools; structure and use of woods, principles of seasoning and influences affecting their growth. Lectures and practice. I.; M., or Th., 5, 6, 7; (1).

4. **Forging.** Care of forge fire; heating, drawing out, bending, upsetting, heading, swaging, welding, hardening, tempering and annealing; tool making and dressing; properties of iron and steel, effects of mechanical and heat treatment. Lectures and practice. I.; W., 5, 6, 7; S., 2, 3, 4; (2).

6. **Wood-Turning.** Various exercises in turning on centres and with screw centres; face-plate, chuck work and ornamental turning. Prerequisite, Shopwork 3. II.; T., 5, 6, 7; (1).

7. Pattern-Making. Patterns and core boxes for moulding simple structural and machine elements; two and three-part flask work. Prerequisite, Shopwork 6. II.; Th., 2, 3, 4; (1).

9. Foundry. Moulding from patterns made by the students and from such other patterns as are necessary to illustrate the principles of foundry practice; mixing and tempering, moulding and core sands; making and baking cores; preparing castings for the machine shop. II.; T., 2, 3, 4; (1).

10. Elementary Machine Work. Bench work in iron; chipping, filing, fitting, scraping, polishing; formation of straight edges, surface plates, gauges, etc.; machine tool work with drill press, lathe, shaper, planer and drill grinder, production of small tools for the machine shop. Prerequisite, Shopwork 4. II.; M., W., 5, 6, 7; (2).

12. Mechanical Construction. Work from students' designs and drawings; manufacture of special apparatus for shop and laboratory use; design and construction of modern machine tools, motive-power machinery and accessories. Prerequisite, Shopwork 10. Lectures and practice. I.; T., Th., 1, 2, 3; T., 5, 6, 7; (3).

SOCIAL SCIENCE AND EDUCATION.

Professor Michel.

Sociology. The course thus entitled is designated to lead the students to reflect upon the relation between individual man and the social whole of which he is a part, and to consider the history of social development as a means of reaching an intelligent and sympathetic appreciation of the significance of society for human wellbeing. Wright's Practical Sociology was used last year as a guide book, supplemented by lectures and by the individual study by each member of the class of the sociological theories or investigations of some one of the foremost students of Sociology whose work was accessible in English, such as Aristotle, Comte, Lester F. Ward, Buckle, Kidd, Tarde, Brooks Adams, E. A. Ross, et al., the results of which study were reported to the class. Lectures, recitations, discussions and reports. I.; (1).

Psychology. James' Psychology (briefer course) is used as text book. In addition, individual essays based on "Halleck's Education of the Central Nervous System" will be made a supplementary part of this course. I.; (2).

Pedagogy. An introduction to the science of education, designed primarily for the benefit of the Home Economics students intending to teach; elective for others. Lectures, discussions and reports. II.; (2).

This type of modern engineering is largely due to technical education, whose results may not be ascribed so much to those of the departments of instruction directly applicable to practice as they have been to the inculcation of scientific principles and logical methods of procedure, thereby training powers of continuous application; and, above all, the spirit of technical institutions imbuing young minds with the inspiration of a definite purpose."—C. J. H. Woodbury, A.M., Commencement Address, 1905.

LIST OF STUDENTS—1905-1906.

ENGINEERING COURSES.

Abbreviations: Ch. E., Chemical Engineering; C. E., Civil Engineering; E. E., Electrical Engineering; M. E., Mechanical Engineering.

Seniors.

Ahles, Carl Christian	C. E.	Redwood.
Burrows, Robert Jay	E. E.	Youngstown, Ohio.
Cady, Ceylon Roy	M. E.	Brushton.
Cummings, Francis Patrick	E. E.	Raymondville.
Flint, Frank Heath	C. E.	Parishville.
Flint, Roger Dean	C. E.	Potsdam.
Leonard, Ralph Burton	E. E.	Malone.
McIntyre, Arthur Bender	E. E.	Williamson.
Murdock, Louis William	E. E.	Livingston Manor.
Perkins, Francis Long	E. E.	Potsdam.
Phelps, Howard Sanford	E. E.	Moravia.
Simpson, Abel Farrington	C. E.	Potsdam.

Juniors.

Craig, Charles Leon	C. E.	St. Lawrence.
Dullea, Maurice Francis	C. E.	Brasher Falls.
Finch, Floyd Ray	E. E.	Livingston Manor.
Gleason, Claude Franz	C. E.	Caneadia.
Hawley, Jean Hodgkins	C. E.	Colton.
Huntington, Robert Charles	E. E.	Malone.
Meacham, Archibald Chas. William	C. E.	St. Regis Falls.
Thomson, David Dittmar	C. E.	Watertown.
Wellington, Ivan Roy (A. B., St. Lawrence University, 1901)	C. E.	Canton.
Wiswell, Ray Duane	C. E.	Potsdam.

Sophomores. (Matriculated).

Cochrane, Clarence Laverne	Andover.
Goodrich, Ralph Herbert	Owego.
Grieb, John Jacob	Brier Hill.
Hardenburgh, Joseph Rock	Roscoe.
Lynch, Jerry Paul	Stockholm Centre.
Merriman, Charles Stephen	Black River.
Moulton, Karl	Cuba.
Roulston, Harvey R.	Heuvelton.
Rutherford, Lewis	Waddington.
Safford, Rufus Lasher	Glens Falls.
Schrodt, John Philip	Black River.
Sprague, Hugh Max	Potsdam.
Tracy, Grant	Andover.

Freshmen.

(Matriculated and Candidates for Matriculation).

Biche, Adrian James ---------- Black River.
Burch, Byron Fred ---------- Potsdam.
Cassada, Arthur Bruce ---------- Potsdam.
Conklin, Herbert Terry ---------- Patchogue.
Eastman, George Lockwood ---------- Potsdam.
Gorman, Laurence Joseph ---------- Madrid.
Mathews, George Bonney ---------- Potsdam.
Mayhew, Valier ---------- Watertown.
Morse, Bryan Woodward ---------- Washington, D. C.
McCullough, Lee William ---------- Millers Falls, Mass.
McNulty, John ---------- Potsdam.
Rodger, George McGregor ---------- Hammond.
Rushton, Sidney Pflaum ---------- Canton.
Scofield, Hervey Noble ---------- Mohawk.
Strough, Roscoe Perrin ---------- Potsdam,
VanHorne, Theodore ---------- Cooperstown.
Welker, Loy Ellsworth ---------- Oil City, Pa.
Welker, George Ernest ---------- Oil City, Pa.
Wellington, Earl Alton ---------- Canton.
Young, John Alfred ---------- Potsdam.

Specials.

Corwin, Allen Winfred ---------- E. E. ---------- Andover.
Hinds, Charles Leo ---------- M. E. ---------- Malone.
Owen, Charles Duane ---------- E. E. ---------- Manlius.
Sisson, Lewis Hamilton ---------- Drawing ---------- Potsdam.

HOME ECONOMICS.

Four Year Baccalaureate Degree Course.

Seniors.

Hale, Irma ---------- Canton.
(B. S., St. Lawrence University, 1903)
Parker, Mildred Mae ---------- Morrisville.

Two Year Certificate Course.

Second Year.

Bush, Sarah Edna ---------- Canajoharie.
Frame, Corinne Marietta ---------- Clayton.
Hungerford, Ruth Mabel ---------- Evans Mills.

First Year.

Danforth, Lena Elizabeth ---------- Massena.
Fulton, Lucy ---------- Carthage.
James, Zuba Earle (Mrs.) ---------- Darlington, Wis.
Mott, Stella Celestia ---------- Potsdam.
McCarthy, Anna Elizabeth ---------- Norwood.
Rickett, Lelia Wenonah ---------- Heuvelton.
Signor, Katharine Agnes ---------- Ridgway, Pa.

Special.

Kendall, Julia Prudence ---------- Potsdam.

Summary of Students, 1905-1906.

Engineering Courses:

Seniors	12
Juniors	10
Sophomores	13
Freshmen	20
Specials	4
Total	59

Home Economics:

Senior (Baccalaureate degree course)	2
Second year (Certificate course)	3
First year (Certificate course)	7
Specials	1
Total	13
Total in the School	72

WEATHER REPORT.

Report to March 31, 1906. Observations made at Clarkson School of Technology, Potsdam, N. Y.	Average. Temperature. Max.	Min.	Mean.	Barom inches.	Totals. Precip. inches.	Snow inches.
Month ending Oct. 31, 1905	59.3	37.0	48.1	29.67	3.69	
" " Nov. 30,	42.0	25.0	33.5	29.62	2.44	8.5
" " Dec. 31,	31.2	14.3	26.9	29.69	4.00	30.5
Week ending Jan. 6, 1906	31.7	17.7	25.4	29.47	0.85	5.0
" " " 13,	24.8	6.0	15.8	29 64	0.32	4.0
" " " 20,	31.1	15.7	25.3	29.53	0.63	4.0
" " " 27,	46.7	25.5	36.1	29.91	0.10	
" " Feb. 3,	34.0	9.0	21.3	29.64	0.30	1.0
" " " 10,	17.7	-5.0	6.7	29.82	0.45	5.0
" " " 17,	32.0	1.4	16.7	29.88	0.27	3.0
" " " 24,	47.6	25.6	36.5	29.65	0.23	1.5
" " Mar. 3,	28.8	10.3	21.	29.64	0.27	1.0
" " " 10,	31.5	18.4	25.7	29.58	0.45	
" " " 17,	27.0	7.7	17.2	29.74	0.21	3.0
" " " 24,	29.0	10.1	19.	29.85	0.78	9.5
" " " 31,	44.5	9.7	34.	29.69	0.90	
Month ending Jan. 31, 1906	35.9	15.9	25.3	29.64	2.12	13.0
" " Feb. 28,	32.3	6.7	19.9	29.74	1.22	11.5
" " Mar. 31,	32.0	11.0	23.1	29.72	2.38	13.0

The precipitation includes all rain fall and snow melted.

DEGREES AND CERTIFICATES.

Degrees conferred, Certificates awarded and subjects of theses presented for graduation, sixth annual Commencement, June 9, 1905.

Degrees.

Bachelors of Science in Civil Engineering.

Clinton Alonzo Curtis, ...Potsdam, N. Y.
Lloyd Woolsey Greene,.. .. ..Watertown, N. Y.
Joint Thesis: Design of a Gravity System of Water Supply for Potsdam, N. Y.
Chester Enos Hudson,.. .. ..Clayton, N. Y.
Thesis: The Micrographic Structure of Steel and Alloys.
Albert Lawrance Sayer,.. .. ..Ogdensburg, N. Y.
Abram Torrey Van Horne,.. .. ..Springfield Center, N. Y.
Joint Thesis: Discharge of Racquette River at Potsdam, N. Y.

Bachelors of Science in Electrical Engineering.

Harry Barney Claflin,.. .. ..Potsdam, N. Y.
Silas Stanley Stone,.. .. ..Potsdam, N. Y.
Joint Thesis: Experimental Study of a Standard Induction Motor.
Harold Sherman Dunsford,.. .. ..Watertown, N. Y.
Michael Leo Stack,.. .. ..South Otselic, N. Y.
Joint Thesis: Design and Method of Construction of a Two Horse Power Induction Motor.

Bachelor of Science in Home Economics.

Charlotte Dezell Seaver,.. .. ..Potsdam, N. Y.
(B.S., St. Lawrence University, 1882.)
Thesis: The Economics of Electric Cooking.

Certificates.

For Two Year Course in Home Economics.

Addah Louise Barr,.. .. ..Ogdensburg, N. Y.
Thesis: Kitchen Utensils.
Anna Belle Cameron,.. .. .. Chippewa Falls, Wis.
Thesis: The Domestic Science Problem in America.
Edith May Ingalls,.. .. ..Hopkinton, N. Y.
Katharine Barker Johnson,.. .. ..Clayton, N. Y.
Joint Thesis: The History and Development of American Homes.

ALUMNI.

Clarkson Tech. Alumni Association.

Officers for 1905-1906.

George A. Stebbins, '01, President.. .. ..Watertown, N. Y.
William J. Fox, '02, Vice-President.. .. ..Syracuse, N. Y.
Charles A. Pohl, '02, Secretary.. .. ..Fulton, N. Y.
Norman L. Rea, '01, Treasurer.. .. ..Schenectady, N. Y.

(An Employment or Co-operative Bureau for Clarkson Tech. graduates is maintained by the Alumni Association. Secretary for 1905-1906, F. Casper Zapf, Schenectady, N. Y.)

1900.

Robert H. Fenn, B.S. in Mechanical Engineering, Mechanical Engineer, Kent Mill Company, 170 Broadway, New York, and for mail, Suffern, N. Y.

Julius R. Jacobson, B.S. in Electrical Engineering, General Electric Company, and for mail, Construction Department, General Electric Co., Schenectady, N. Y.

Charles H. Lawrance, B.S. in Electrical Engineering, Instructor in Drawing and Mechanics, College of Agriculture and Mechanic Arts, West Raleigh, N. C.

Carlton E. Smith, B.S. in Electrical Engineering, Thompson Starrett Company, 51 Wall St., New York, and for mail, 6 B. St., N E., Washington, D. C.

1901.

Robert T. Danforth, B.S. in Electrical Engineering, St. Lawrence River Power Co., Massena, N. Y.

John E. Harriman, B.S. in Electrical Engineering, Home Telephone Company, and for mail, 1522 Troost Ave., Kansas City, Mo.

Norman L. Rea, B.S. in Electrical Engineering, General Electric Company, and for mail, 228 Liberty St., Schenectady, N. Y.

George A. Stebbins, B.S. in Electrical Engineering, Secretary Stebbins Engineering and Manufacturing Co., 74-78 Smith Building, and for mail, 36 Keyes Ave., Watertown, N. Y.

Sidney L. Wailes, B.S. in Electrical Engineering, Manager, Western Branch National Electric Company, Milwaukee, Wis., and for mail, Room 311, No. 519 Mission St., San Francisco, Cal.

William H. Wilcox, B.S. in Civil Engineering, Lowville and Beaver River R. R. Co., Lowville, N. Y.

1902.

Walter N. Brand, B.S. in Mechanical Engineering, Assistant Mechanical Engineer, Smith Premier Typewriter Company, and for mail, 519 Park Ave., Syracuse, N. Y.

William G. Evans, B.S. in Civil Engineering, Assistant Engineer, South Park Commission, 57th St. and Cottage Grove Ave., and for mail, 4952 Forrestville Ave., Chicago, Ills.

William J. Fox, B.S. in Electrical Engineering, Westinghouse Electric and Manufacturing Company, 902 University Block, and for mail, 319 W. Genesee St., Syracuse, N. Y.

Rea M. Gordon, B.S. in Mechanical Engineering, Assistant to Engineer of Tests, Solvay Process Co., and for mail, 319 W. Genesee St., Syracuse, N. Y.

Harry F. Halladay, B.S. in Mechanical Engineering, Instructor in Mechanical Engineering, University of Vermont, and for mail, 16 Colchester Ave., Burlington, Vt.

Joel M. Howard, B.S. in Mechanical Engineering, Assistant Engineer, Sicilian Asphalt Paving Company, Times Building, and for mail, 273 W. 140th St., New York, N. Y.

Sanford C. Humphrey, B.S. in Electrical Engineering, Inspector, U. S. Engineer's Office, Wellsville, O., and for mail, Carthage, N. Y.

Otis C. Loomis, B.S. in Mechanical Engineering, Henry, Dillman & Loomis, Civil and Mining Engineers, Rooms 47-49 Altoona Trust Building, and for mail, 620 Oak Ave., Altoona, Pa.

Wait R. Loveless, B.S. in Electrical Engineering, Electrician, Pennsylvania Railroad Co., and for mail, 1428 8th Ave., Altoona, Pa.

Charles A. Pohl, B.S. in Civil Engineering, Assistant Engineer, New York State Barge Canal, and for mail, 420 Oneida St., Fulton, N. Y.

Charles B. Richardson, B.S. in Electrical Engineering, District Engineer, Wagner Electric Manufacturing Co., 1625 Marquette Building, Chicago, Ill.

George J. Stanley, B.S. in Electrical Engineering, Sales Department, Pittsburgh Reduction Co., 131 State St., Boston, Mass.

Carlton E. Ward, B.S. in Civil Engineering, St. Louis & Minneapolis R. R., and for mail, 1141 Metropolitan Life Building, Minneapolis, Minn.

1903.

Benjamin F. Batchelder, B.S. in Civil Engineering, with Williams, Proctor & Potts, Sanitary Engineers, 1702 Whitehall Bldg., New York City.

J. Everett Beswick, B.S. in Civil Engineering, Rapid Transit Railroad Commission, Division Engineer's Office, 4 Court Square, Brooklyn, and for mail, 123 E. 18th St., New York City.

Burton L. Delack, B.S. in Electrical Engineering, General Electric Co., and for mail, 820 Lincoln Ave., Schenectady, N. Y.

George O. Hodge, B.S. in Mechanical Engineering, Eisenhuth Horseless Vehicle Co., and for mail, 388 Main St., Middletown, Conn.

Frederick M. Lehr, B.S. in Electrical Engineering, Stone Mills, N. Y.

George G. Sweet, (A.B. Cornell University, 1901) B.S. in Civil Engineering, New York State Barge Canal Office, De Graff Building, and for mail, 11 Lancaster Ave., Albany, N. Y.

1904.

Samuel F. Carlisle, B.S. in Civil Engineering, Department of State Engineer, and for mail, 9 S. Hawk St., Albany, N. Y.

Charles A. Gridley, B.S. in Civil Engineering, Assistant Engineer Corps Southern & Western Railroad, and for mail, Fink, Va.

Ralph D. Hayes, B.S. in Civil Engineering, New York State Engineer Department, and for mail, Occidental Hotel, Goshen, N. Y.

Frank C. Zapf, B.S. in Chemical Engineering, Chemist, General Electric Co., and for mail, 423 Summit Ave., Schenectady, N. Y.

1905.

Harry B. Claflin, B.S. in Electrical Engineering, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa., and for mail, 503 Franklin Ave., Wilkinsburg, Pa.

Clinton A. Curtis, B.S. in Civil Engineering, Engineer Corps, New York State Barge Canal, and for mail 301 Germania Ave., Schenectady, N. Y.

Harold S. Dunsford, B.S. in Electrical Engineering, Testing Department, General Electric Co., and for mail, 818 Lincoln Ave., Schenectady, N. Y.

Lloyd W. Greene, B.S. in Civil Engineering, R. W. & O. Division, New York Central Railroad Co., and for mail, 23 Burchard St., Watertown, N. Y.

Chester E. Hudson, B.S. in Civil Engineering, Engineering Department, Manufacturers' Automatic Sprinkler Co., Weld Building, Boston, Mass., and for mail, 31 McLellan St., Dorchester, Mass.

Albert L. Sayer, B.S. in Civil Engineering, with Wallace C. Johnson, Consulting Engineer, Niagara Falls, N. Y., and for mail, Ogdensburg, N. Y.

Charlotte D. Seaver, (B.S. St. Lawrence University, 1882) B.S. in Home Economics, Supervisor of Home Economics, Public Schools, and for mail, 701 Sewall Ave., Asbury Park, N. J.

Michael L. Stack, B.S. in Electrical Engineering, Stanley—G. I. Electric Manufacturing Co., and for mail, 193 Woodlawn Ave., Pittsfield, Mass.

Silas S. Stone, B.S. in Electrical Engineering, Testing Department, General Electric Co., and for mail, 301 Germania Ave., Schenectady, N. Y.

Abram T. VanHorne, B.S. in Civil Engineering, Pennsylvania Railroad, General Offices, Pittsburg, Pa., and for mail, 2579 Broadway, Cleveland, O.

HOLDERS OF CERTIFICATES.

Two Year Course in Home Economics.

1898.

Mary E. (Sanford) Capron, Great Falls, Montana.

Melita N. (Heward) Ostrander, 3020 Euclid Ave., Cleveland, O.

Helen M. Story, Domestic Science Supervisor, Public Schools, and for mail, 152 Vandervoort St., No. Tonawanda, N. Y.

1900.

Alice (Perrigo) Brown, Potsdam, N. Y.

Grace A. (Matteson) Grosh, 721 Hall Ave., St. Mary's, Elk County, Pa.

Georgina Pflaum, Stenographer, Office, County Judge of St. Lawrence Co., Canton, N. Y.

Jeannette W. Scruton, Teacher of Domestic Science, High School, and for mail, 29 S. Willow St., Montclair, N. J.

Mabel C. Whittier, Teacher of Domestic Science, Cleveland Orphanage, Versailles, Ky.

Margaret M. (Bowen) Wright, Swan River, Manitoba, Canada.

1902.

Susan F. Batchelder, Teacher of Domestic Science, High School, and for mail, 7 N. Wendall Ave., Schenectady, N. Y.

Sara A. Crane, Teacher of Manual Training, Board of Education, Longmont, Col.

Genevieve M. Denneen, Teacher of Domestic Science, Public Schools, and for mail, 102 Second St., South Orange, N. J.

Mary A. Pierce, Moira, N. Y.

1903.

Annie R. (Patterson) Crosby, Massena, N. Y.

Hattie M. Smith, Teacher of Domestic Science, and for mail, 114 B State St., Watertown, N. Y.

May P. Varney, Teacher of Domestic Science, House of Refuge, and for mail, 900 N. 22d St., Philadelphia, Penna.

1904.

Bessie E. Andrews, Pierrepont, N. Y.

Frances M. (Barnes) Buskirk, 17 Rhodes Ave., Lynn, Mass.

Jessie D. Child, Substitute Teacher of Cooking, Elementary Schools, and for mail, 1879 Morris Ave., New York City.

Nina M. Merry, 1 Elizabeth St., Ogdensburg, N. Y.

Florence B. Rutherford, Waddington, N. Y.

Mary F. Signor, Supervisor Domestic Science and Art, Marquette High School, and for mail, 327 High St., Marquette, Mich.

Anna L. Smith, Lisbon, N. Y.

Marion Sparrowhawk, Teacher of Sewing, Public Schools, and for mail. 131½ Watertown Ave., Yonkers, N. Y.

1905.

Addah L. Barr, 52 Jay St., Ogdensburg, N. Y.

Anna B. Cameron, 140 W. Cedar St., Chippewa Falls, Wis.

Edith M. Ingalls, Teacher of Sewing, Delaware Industrial School, Wilmington, Del.

Katharine B. Johnson, Clayton, N. Y.

"While the young engineer may look forward with reasonable assurance to honorable, and probably, to remunerative employment throughout his professional career, he will, sooner or later, discover what we all discover, that life is more than meat and the body more than raiment. My acquaintance among engineers leads me to say frankly that as a class they escape many infirmities which beset and often ruin their brethren in other professions. An engineer, while a man among men, is seldom less than the best specimen of a man among men. The outdoor life; the dealing with real and important problems; the perpetual newness of the questions which arise, and usually, the large responsibility which rests upon the engineer, compel him to live a fair, clean, admirable life. He reports on the facts as they unfold themselves to him, and to nature here is a constant corrective. False reports, if acted upon, lead to litigation and exposure, and a career might easily be closed by the terrible testimony which a lawsuit entails. As an expert he naturally gravitates toward the centre of largest service and highest reward."—Francis Newton Thorpe, Ph.D., Commencement Address, 1904.

"The present occasion calls sharply to our attention the coming into existence, during the past few years, of a new type of school, which is out of the ordinary line of ascent; which does not confine itself to a definite place in the educational order, but seeks objects of its own, and is at liberty to use all the agencies, instrumentalities, and methods which are appropriate thereto. But every believer in the new education must regard their establishment with great satisfaction, looking at them, not only for much positive good in the education and life preparation of their own pupils, but also for much that will be valuable in the way of suggestion, both as to subjects of study and as to the most effective methods of presenting such subjects. Each comes into the field with a 'free hand', bound by no traditions; perfectly at liberty to seek the best, from whatever source; to prove all things and to hold fast to that which is found good; ready, eager, and anxious to occupy every part of the ground which has been overlooked or neglected in the existing system of instruction. They purpose to make themselves; not to be fitted into a place in a system. Their ultimate form is not easy to conjecture. Herein is one of the chief reasons for the hope of their future usefulness. Every friend of education must watch their course with interest."—Francis A. Walker, Ph. D., LL.D., in the Dedicatory Address, of the Thomas S. Clarkson Memorial School of Technology, November 30, 1896.

"I predict for the Clarkson Memorial School of Technology great success and a bright and glorious future. In behalf of the profession of civil engineers in our country, I know that I voice the feelings of all its members when I tender to this faculty, the board of trustees, and all who have aided in this organization and management, our warmest thanks and pledge our active assistance whenever and however we may have opportunities to give it. Centuries may elapse before the solid walls they have built will crumble, and then on and on through centuries more the knowledge which has been gained and imparted will survive to bless the world."—William Sooy Smith, Consulting Civil Engineer, Founder's Day Address, 1904.

"This evening's exercises fitly commemorate the Founding of this School of Technology; they commemorate a great event; great in the history of our educational institutions; greater comparatively to this community, but none the less great as contributing to the world's good and betterment. It marks the realization of the wish of three sisters to confer upon future generations the blessings of a useful training and a practical education, and the desire to perpetuate the memory of a beloved brother. It marks an act that demonstrates the wonderful foresight that belongs to few, the unselfishness of the great heart and that faith in the mankind and the future which characterizes the true Christian spirit. These are what make our true philanthropists. It should be a blessing to the founders of this institution that they may see and know the great good that has resulted from their benevolence, during the first ten years of its history now closing."—John Cassan Wait, M.C.E., LL.B., Founder's Day Address, 1905.

CLARKSON SUMMER SCHOOL.

Third Session—1906.

The object of holding this summer session of six weeks, is to offer the facilities of the school and to provide instruction for teachers and advanced and special students, and those who are preparing to pass the grade and State examinations in August; for college students who through failure in any course wish to prepare for September examinations; and for those who are preparing to enter college.

COURSES OF INSTRUCTION.*

Electrical Engineering. Course in elementary and applied electricity, lectures, problems and laboratory work, will be given if a sufficient number apply for it.

History and Literature. Courses in English and American Literature; Ancient, Medieval and English History.

Languages. Courses offered in ancient and modern languages, for beginners or advanced students and teachers, including Latin, Greek, French, German and Spanish.

Mathematics. Courses offered in advanced Algebra, Solid Geometry and Trigonometry.

Home Science. Courses in Cookery, Sewing, Basketry, and Sloyd, lectures, laboratory work, individual instruction; with special reference to the needs of those preparing to teach Home Science.

Manual Training. Courses in bench work in wood and Venetian ironwork, combined with constructive drawings and making models and ornamental designs.

EXPENSES.

The tuition will be from $5.00 to $12.00 per subject, according to branches and character of work taken. Expenses for laboratory and other materials necessary will be charged at cost, as may be required. All students taking courses in practical work will be charged for injury to apparatus and for breakages.

Boarding. Excellent boarding arrangements may be made, at reasonable rates, as given in this Bulletin, under the item of expenses for attending the Clarkson School of Technology.

Circulars containing full information of each of the courses announced will be sent upon application to

Carl Michel, Ph.D.,
Secretary, Clarkson Summer School,
Potsdam, N. Y.

July 5, Thursday.. .. ..Instruction begins
August 16, Thursday.. .. ..Instruction ends

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*If the arrangements for instruction during the summer make it possible to give other courses, they will be announced in the next issue of Clarkson Bulletin.

THOMAS S. CLARKSON
MEMORIAL
SCHOOL OF TECHNOLOGY
POTSDAM, N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language, literature and history, mathematics, the natural and economic sciences, engineering and technology. The instruction is largely taken in common, during the first two years, and provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of the applied sciences, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting investigations.

The technical instruction of the last two years, in theory and practice, affords substantial preparation for immediate usefulness after graduation by intelligent application of principles to the successful mastery of the details of the chosen field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their profession.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical or mechanical engineering. The four year course in home economics for women offers a full college training, whose aim and scope are to prepare for teaching home economics, as well as for the efficient management and supervision of the home.

These courses of instruction lead to the degree of Bachelor of Science in the major subject pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

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THOMAS S. CLARKSON
MEMORIAL
SCHOOL OF TECHNOLOGY

POTSDAM, N. Y.

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The Director,
Clarkson School of Technology,
Potsdam, N. Y.

WORKERS TOGETHER WITH GOD.*

By The Right Rev. Richard Henry Nelson, D.D.,
Bishop-Coadjutor, of Albany.

I Cor. iii; 9.—"For we are labourers together with God; ye are God's husbandry, ye are God's building."

This passage might have been translated so as to bring out more clearly the distinction of ideas which is expressed in the contrasted clauses; thus, "God's fellow workers are we; God's husbandry, God's building are ye."

St. Paul is here speaking of his ministry as a working with God, while the Corinthian Christians are compared to the field or building in which the work is done. We may, however, take one of his phrases oue of its immediate setting, and employ it to describe the relation of every productive life to the Author of intelligent activity. "God's fellow workers are we." Here is a statement which dignifies every kind of true work, while, at the same time it pays due tribute to God by recognizing His sovereignty over all processes of advancing life.

Let us therefore endeavor to outline this idea of God as the Supreme Worker in creation, in order that we may better understand what is meant by co-operation with Him.

We say that God has self-conscious personality. Not that these words, coined in the mint of our own mental experience, can claim to be an adequate description or definition of God's Being, but merely that they ascribe to Him in infinite degree, qualities which are essential to any conception of intelligent existence. God is, then, a Personal Being of supreme power and intelligence, who originates, directs and controls all of the forces which enter into life. It is said that God is so completely identified with Creation, that it cannot be conceived of as existing without Him; and yet, that He is so independent of it that He would continue for eternity, though every created thing should perish.

We further declare that God is benevolent because "His everlasting purposes embrace all accidents, converting them to good," or, in other words, because He is the Author of that universal and eternal harmony toward which all life is moving, and in which all creation shall find abiding happiness.

If we are to succeed in our attempt to reason out from a true idea of God to a satisfactory conception of man's relation to the world's work, we must take pains to make our outlook sufficiently broad, and, to this end, I ask you to dwell for a moment upon some thoughts suggested by this place.

Here, in Potsdam, we are standing upon a geological formation which represents one of the oldest strata of our earth. To understand the part played by the sandstone of this region in the history of creation, we must go back in thought over thirty-two of the thirty-six geological generations of the earth's crust. Back through all human history; beyond the days of the earliest mammalian life; before the era of huge reptiles; earlier than the age of coal deposits; back throug myriads of years to the primeval epoch of skullless animals and tangle forests, when God saw the beginning of a work the purpose of which could not be known to any created intelligence until millions of years

*Baccalaureate address delivered on Sunday, June 10, 1906.

had passed. No idea of God's relation to the world is so awe-compelling as this, which exhibits Him in His infinite patience as well as in his infinite wisdom and power, watching through innumerable years over the process of growth toward perfection.

Leaving now the bewildering thought of the vast periods represented by the geological strata of the earth, we may take our place in the more rapid movement of the quaternary epoch which is the age of man and of culture.

In comparison with the earlier periods, the duration of man's life upon the earth has been very short; not, as was once claimed, extending over millions of years, but according to more recent calculations, beginning after the glacial period and not more than ten or fifteen thousand years ago.

By steps which we can describe only in general terms, the man is seen to come forth from the lower orders of mammalian life until the guiding mind of God finds him ready for a new gift in the possession of which he will at once rise to a place of dominion over the earth and its inhabiters. "The Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul": a self conscious being, reflecting the image of his Maker, and destined henceforth to share his Creator's work, "a labourer together with God."

At first, the task assigned to the man is of the simplest order. He is put into the Garden to dress it and to keep it, under a strict injunction of obedience, lest failing to work with God he should lose sight of the purpose for which he was made.

Now note the subtle form in which that first temptation came. "In the day that ye eat of it, ye shall be as God." To be as God! Is not this the purpose for which the man was made? Was he not designed to realize the image of God in which he was created? Yes, but not by setting his will against that of his Maker; not by disobedience and discord. His eyes should indeed be opened to know good and evil, but he was to learn in sorrow and toil that good consists in co-operation with the perfect will of God, while evil is the contradiction of that will.

So the man is pictured going forth from the Garden to earn his bread in the sweat of his brow, to encounter the thorns and briers of difficulty, and to learn the meaning of life by patience, submission and gradual mastery of self. It was no part of the Divine purpose to condemn the man, who was the fruit of such long labor. Work was not to be mere penal servitude, but rather a process of redemption. He was to meet difficulties and to overcome them; he was to labor among thorns until they should blossom as the rose, and the whole earth become a garden; he was to rise through success to clearer perception of God's purpose, until, in the glories of the Heavenly Jerusalem, he should find the end of the world's work, the "City whose maker and builder is God."

It is exceedingly interesting and suggestive to find, in the fourth chapter of Genesis, how quickly the idea of work began to expand. Jabal is declared to be "the father of such as dwell in tents and of such as have cattle"; Jubal, "the father of all such as handle the harp and pipe"; Tubal-Cain, "the forger of every cutting instrument of brass and iron". Here is sketched in outline the beginning of the technical arts which were destined to make such marvellous progress

in subsequent times. Soon, men began to build cities, and in ages remote from ours, they accomplished engineering feats before which we, with all our boasted powers must stand in dumb amazement. Some of these ancient buildings represent co-operation with God's purpose toward the world. The accomplishment of great tasks is in itself a part of the moral progress toward dominion over the earth; the cultivation of art awakens and fosters man's love of the beautiful and so contributes to his spiritual elevation; the building of temples keeps alive his consciousness of relation to the great Master Workman.

But there is another side to the picture. The old spirit of self-will asserts itself at Babel, and confusion takes the place of harmony. Other buildings speak of vice and cruelty, and of mighty powers prostituted to the basest ends, until cities are left in ruined heaps and palaces become shapeless mounds, mute witness to the inexorable law which declares that "the wages of sin is death,"

But, on the whole, there is progress, and the world's work goes forward until, in the days of the Roman Empire, it might seem that an end had been reached. What more could the mind desire than the idea of a world-power embodied in the organization whose center was the Eternal City, with its roads radiating outward through a mighty Empire? What idea of religion could be more inspiring than that symbolized by the Temple at Jerusalem, the fixed center of worship to which the nations brought their offerings?

And yet all the forces which combined to produce these apparently final results are now seen to have been merely collecting themselves for the real work of man in the world. As the tiger gathers every tense and quivering muscle for its magnificent rush and spring, so, at this crucial moment, the powers of man are preparing for an outward march and an upward movement to which all previous efforts have been but the preface. A motive power is needed to give life to the human machine, and, as at the beginning of man's history, so now, in the fullness of time, it is a gift from above that furnishes the required impulse. Then, God breathed into man's nostrils the breath of life, and man became a living soul. Now, God enters into the life of the race in His own Divine Person, and the God-man stands on the earth. The incarnation completes the process which began when primordial elements received the gift of life from him who has life in Himself.

Note, now, how the centrifugal force asserts itself with the coming of Christ. Outward from Jerusalem and Rome, along roadways built to lead men to these cities, the stream of humanity is seen to move with a new purpose, until, under this mighty impulse, man begins to occupy the earth's remotest bounds. Look at the world's map today, and mark how every continent and island is known, and there remain only the frozen fastness of the North and South against which indomitable effort continues to hurl itself with slow but persistent success.

Consider our own country, and the extension of its civilization in little more than a century, from a trembling chain of colonies, to an Empire so vast that few of us have even begun to comprehend its immensity.

Then note how the scattered territories which have become the home of man, are bound together by his inventive genius, until the throb of human life in China and Japan is felt instantaneously in the Western Hemisphere.

Can your minds grasp the relation of this present world, with its thousand millions of closely related inhabitants, to the simple cell life which once found sustenance and multiplied itself in the Potsdam sandstone? Can you rest content with an idea of life which is bounded by the eating and the drinking, or the labor and the study of a single day or year, when the voices of the ages unite to tell you that you are workers together with God, parts of the vast scheme that laid the earth in its successive strata, that made man, and dwelling in man has enabled him to lay his hand upon a unified world?

Or can you rest content with any idea of work which, neglecting inspiration from the past, is deaf also to the call of the future?

"Workers together with God!" Surely, this means that we must enter into all of our inheritance, and use it all for those high purposes for which it is entrusted to our care.

Let us, therefore, look at the world's work of to-day and consider what are its ideals. At first sight, it may seem to be hopelessly lacking in appreciation of its higher opportunities. There is much to condemn in the wide-spread love of money, and in the increase of luxury, greed and multiform selfishness, but, on the other hand, there is an undertone of earnest purpose which, I will venture to assert, is the real tone of our age.

There is an enthusiasm for knowledge, and a love of work for the work's sake which shows that the sons of God have not lost their Father's spirit. Perhaps there is danger in our modern exploitation of knowledge as the all-to-be-desired end of effort; there may be danger in losing our hold upon the eternal purpose in our enthusiasm for the special work of the present. But I am sufficiently sanguine, yes, I have enough faith in God and man to believe that the whole truth concerning life must inevitably conquer partial or imperfect truths, and that the whole man will certainly work more and more toward an ideal of co-operation with God in all departments of the varied activities by which the universe moves onward to its spiritual end. Believing this we may study the work of our day in the light of its relation to these larger purposes. It is impossible, within our limits of time, to discuss this in detail; we can only touch upon a few general principles, and chiefly upon this, that every kind of work has moral value according to the purpose which it is made to serve.

Much of the product of American labor is stamped with the mark of crudity. It bears on its face the story of its making, and confesses that it had no purpose except to find a market with the least possible expenditure of effort. It is the symbol of a bare and unblushing commercialism. In other days, and under the fathering care of various guilds, good work was a matter of pride, and its products had the quality of distinction. The making of a cup might and did bring lasting fame; the carving of a screen might win the applause of centuries. But we, without effective protest, allow towns to be built in which rows of monotonous houses perpetuate an inartistic sense, and public buildings are recognized as such by their conformity to existing types. There are notable exceptions to this, and there is gratifying evidence that men are rising to nobler ideals of creative energy, but the workman of the future must be one who can look beyond personal gain and present utility, seeking perfection in all that his hand finds to do. He must be one whose aim is to produce something better than the world has ever seen, whether it be a better house or a better man,

and this he must do because he is a worker with God and a contributor to the building of the perfect city.

For this reason, he has need of religion. In fact, the fundamental idea of true religion is that it is a working together with God. "My Father worketh hitherto, and I work." said our Lord, and His mission to the souls of men cannot be fully appreciated if it be separated from that which we commonly describe as work. If Christianity has lost any of its hold upon the minds of men, this may be due in part to forgetfulness of the fact that it is a way of right living, and a way of right doing, as well as a way of right thinking and believing. It is a life in accordance with God's purpose as this appears in His works of Creation and Redemption. "Till we all come in the unity of the faith and of the knowledge of the Son of God, unto a perfect man, unto the measure of the stature of the fullness of Christ." The perfect man grows in and through his perfect work, which he performs with a mind enlightened by his knowledge of God's eternal purposes.

We began by considering a single phrase taken from St. Paul's Epistle to the Corinthians; let us now mark his conclusion.

Life, he tells us, may be compared to a building in which we are fellow workers with God. There must be a foundation for the building, and this is Jesus Christ who is the union of God and perfected manhood. On this foundation, and in accordance with the purpose of God as revealed in all His works, we are to build our allotted portions, remembering that all things must at last be brought to judgment, and "the fire shall try every man's work of what sort it is." The "gold, silver, precious stones," of true endeavor and real accomplishment shall endure the ordeal, while the "wood, hay, stubble" of shiftless and perfunctory lives shall suffer their well merited loss.

Knowing this, let us, in the minutest detail, as well as in our whole plan of life, offer our work to God for His approval, and count that day a failure in which we have not consciously striven to make something better than it was before.

WANTED, A TEST FOR "MAN POWER."*

By Ellen Henrietta Richards, A.M., S.B.**

Students and Friends of Students:

Because the graduating class of today has not finished its studies, it has only begun its life work. And today the student in practical life needs friends more perhaps than at any other time. The force which has accomplished work in the world, has always been man power. In the early ages of the world it was literally the raising of weights and carrying of burdens. Yet the terms in which we express our standards are not man power but horse power and foot pounds.

In the course of the ages man has invented machinery to do the lifting and carrying for him—but this inventive ability is force just

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*Copyrighted by Ellen Henrietta Richards, 1906, Boston, Mass.

Address delivered at the Seventh Annual Commencement, June 15, 1906, of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y.

**Instructor in Sanitary Chemistry in the Massachusetts Institute of Technology.

as truly. Progress in mechanical work has been greatly aided by the adoption of standards to which an effective machine must conform. The mental output of man would, I believe, be greatly increased by the adoption of standards of human accomplishment in these newer lines of work.

There is a theory that the great monuments of the world were built by the making of a long incline, and the carrying of heavy stones up the incline very largely by man power. Today the peons of Mexico are doing a great deal of work, cheaper than can be done by mechanical power. It was a very great revelation to me to find that the great drainage canal was excavated in that way—that it was cheaper to have the peons carry the dirt up from the steep banks of the canal than to instal excavators. That was largely on account of the cost of fuel and transportation. I believe today it is cheaper in the mines of Mexico very largely to have these same peons carry the ore sacks up what they call their chicken ladders than it is to instal hoisting machinery.

Think for a moment why it is that that sort of man power is cheaper. Such people live on about three cents a day. And I fancy that a great deal of the labor of the world in the past centuries has been as cheap as that. It is the cheapest kind of labor. The work that they do is not very exhaustive. Their three cents a day does not give them a great deal of extra force. Our Italian and Bohemian and foreign laborers who come here live at the rate of perhaps ten or twelve cents a day, and they do a little more work. Our average American workman wants at least twenty-five cents a day for his raw food material, and he does much more work.

Thus you see that man power, after all, depends a great deal upon the food he eats. If you think a moment you will see why. We hear a great deal today about automobiles, for instance. Did you ever think that you, individually—that every human being—was a self contained motor? We do not have pumping stations where we can go and get charged up for a day's work. We are obliged to manufacture all the energy we have to use; not only what we need to keep ourselves warm and to keep the heart pumping, but any energy which we need to use in other ways we have to manufacture. That is to say from the food we eat, and the exercise we take, and the general good condition we are in, we manufacture this power, this man power, this force—whatever it is—that we have to spend.

It has been estimated by people who have worked along these lines that a man, who has a very good digestion, a very good circulation and lung capacity, is able to do about a fifth as much as a horse; that is, he can carry about a fifth as much weight, or he can lift a load perhaps about a fifth. If you roughly calculate it, a man (using the term in a generic sence) weighing about 150 pounds can carry this weight up 10,000 feet. It is a very good standard of a day's work.

I don't mean we can do it the first time without practice. But that is an ideal—to be able any day to have that feeling of power that we can climb 10,000 feet or carry 100 pounds six miles. The latter is perhaps a little easier, and it is certainly a little more practicable as a test of man force.

We have had in engineering the word "duty" for the efficiency of the machine. This word has gone out of use now, and, curiously enough, along with it, it seems to me, has gone the very idea of duty

anywhere. I am afraid we do not feel very strongly our duty to the world or to ourselves today, and yet the idea of efficiency is just as strong in the world as it ever was. We have turned, as you in this region very well know, from the actual pulling of the horse and the lifting of the machine to electricity.

Now, if we think one moment, electricity gives a much better comparison with the force which we wish to develop in ourselves, whether our own human power proves to be electricity or not. The ideas and terms used come very much nearer to our conception of our own work. We do not visibly see the source of the force as we do in the horse pulling a load, but we know the force is there because of the power evident in results. We use the term efficiency for the result of electric current, and we are transferring that term very generally to human achievement. This efficiency of the human being is analogous in another way to what we know of an electric current. One of the chief elements in the use and control of the electric current, is as you know, resistance. And certainly the graduates who have studied electric cooking know that this resistance brings electric force down into heat. We say it fritters away the energy into heat; that is, the heat is a lower level of energy than the force which we use in the current.

The human body should be a very good electric motor, because we have nerves, these little threads which carry our will, which give us the impulse to the motion. We have the most perfect mechanism in its way, of ropes and pulleys and lubricated joints, that is known. The ordinary machine, as you know—the steam engine, uses only about ten per cent of the liberated energy. When we transfer it into electricity I think we are able frequently to utilize ninety per cent.

Our human bodies ought to utilize a very high per cent. of the energy they make. If you do not carry a hundred pounds six miles, or if you do not climb up a mountain, you need a certain amount of energy for other work, thinking, planning, inventing. I wonder how many of us here have very much spare energy—how much we could really do. If we do not have it, and are not able to accomplish what we set out to do, things are wrong. There is some friction, some resistance reducing the power, or there is some lack of connection. In order to get the full force of electric current we must have all things working together. We must have a good contact between the places whence the force comes and the things we wish to accomplish.

As students in school, we fritter away a great deal of energy into just mere heat work—into friction. We do not accomplish nearly that which we might in school if all the connections between the things we are studying and the results we wanted to get were made. One whole lesson for life, for the work which we are to do afterwards, is to secure this good connection as readily and as quickly as we can.

Therefore, it is, as you will readily understand, that we are making today, more than ever before, a great study of what is the best environment for the production of this human power. For one thing, it is good digestion. The food must not only be eaten, but it must be assimilated. There must be good circulation, because the food must be carried to every tiny cell. I can remember when we supposed almost all the work of aeration, of oxidationwas done in the lungs. Today we know it is in the tiny little cells everywhere that force is liberated. That means that the circulation is of very great importance.

Then we must have good and refreshing sleep, because this energy which is made in the body must have some space of time to accumulate. Those of you who have studied electricity know that there must be an accumulation of energy before we can get a pressure of energy to use.

We must have one other thing which is very much overlooked in this production of man power, and that is good lung capacity. It seems a great pity that students are not taught from the very earliest moment to use the lungs to the full capacity, because we must have the oxygen to burn up the food which we take in order to give us this energy. There is no other way to get it. That is the way which is ordered, and there is no other. Therefore, one of the very first things which is essential for the production of this force is good lung capacity—good breathing power. One should stand right and keep one's shoulders right, and keep such a position as to get the full capacity of the lungs, and we should have the fresh air habit. The school neglects that side of student life. It sometimes seems as if the old academic idea was—here was an individual, and all you had to do was to pour into him a certain amount of knowledge. It didn't matter whether he was in good physical condition or not. In fact, in early days the school and college attempted to educate students weakened with disease, often with a disease so far advanced that they failed very soon after graduation. It was once supposed a student might go to school, and board himself, and live somehow, and starve himself, only if he got a certain amount of knowledge he was fitted for the world.

Today the demands of the world are such that this is not quite true. The engineer who goes into the field, the teacher who goes into college work, the housewife who goes into her own home work, all need a good healthy foundation. They need to have all the nerves in good condition, because of the more exacting circumstances under which we live. It is absolutely necessary today, I believe, to have a sound body to manufacture and to conduct the electrical, or whatever force there may be within us, to the very best advantage. That is why we are preaching so strongly the doctrine of health, of sanitation, of the education in all these things which are given in the various courses of home economics.

This physical efficiency as a basis for mental efficiency is, we believe, the fundamental point of the human production of the force which surely moves the world. And if you stop to think, it is the most valuable force we have. What is a horse worth? $200 perhaps, a good horse that can do the work. What is a man worth? Two thousand, at least. And a good teacher is worth $20,000, if you take the salary expressed as interest. A good engineer is worth $200,000 actual capital. And yet think how much care we put on our $50 pigs or our $200 horse, and what we put on our $200,000 engineers.

There is a great error in the common conception of what force is worth in the world. Why is this human force so valuable? Because today it is the direction of affairs which we expect the human power to take. That is, it can assemble and collate and collect forces and get results. It is the man or the woman who sees the end clearly, who sees what we can do, who sees how this thing can be made better, how the whole thing can go together for human progress. I believe we are feeling very strongly in many quarters our responsibility today,

because each person counts for so much more. The peon digging in the canal has just himself, he lives on three cents a day, and he does just a little bit of work at the superintendent's direction. Now, we who work the forces, who have the powers, want fifty cents a day for food, and we are worth it too, because we are working a great deal more in force and power than has been possible before today.

I do not know whether you remember that definition of Huxley of the educated man, which is so very, very good I think. He says: "That man, I think, has had a liberal education, who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength and in smooth working order; ready like a steam engine to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truth of nature and of the laws of her operations;one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to respect others as himself."

I think there is no better definition of a man today than that.

The difficulty has been a lack of personal responsibility for personal power. When as students we have perhaps been reproved for not doing more, we say, "Oh, well. I was born so." I am afraid many of us have made reply many times when we were criticised for not doing well, "Well, my father never could do that, and my grandfather never could do that." It is an excuse. When I see an acrobatic performer, a very wonderful actor, or any human being who has trained himself to please the public, I always think what an error it is in our schools and colleges that there is not a daily insistence on the fact that a human being can make anything of himself if he is willing to work for it; if he is willing to work for it sufficiently he can accomplish almost anything.

There are very, very few things—there are very, very few cases, where you can lay the blame back on your grandfather. It is because of a lack of will to do.

What we need is a something which will teach us to nourish the will. It is entirely apart from my topic, and I will only say that I think a great deal of our education fails in that line. We have been for the last few years saying a student had better do just as he likes. Those students are going to make for power in the world who can work against resistance, who do a thing because it has to be done. I said a little while ago that this idea of duty which we used to put on the steam engine has gone not only out of mechanical terms, but out of our lives. I repeat, we are a little lacking today, it seems to me, in our idea of duty. That is an ethical side which we cannot take up in this purely material view.

How are we to know whether we have the amount of spare energy that we ought to have? The body can make a certain amount of energy. As a rough estimate I have stated the excess of energy as one-third of the total that the body can make. The heart has to pump the blood, and the body has to be kept warm, and a great deal of energy has to be used up. But I think we ought to save one-third of that total energy to use as we will. Now how shall we know whether

we have any energy to spare? There is probably no greater waste in America than in the line of work of these young graduates just going out this month into the world, wasting their energy because they do not know how to conserve it, how to accumulate it and keep it under their control, because in a great many cases their habits during college life have not given them a habit of saving energy. Remember human energy is the most precious thing we have.

In the old New England days sometimes our people used to answer when asked how they were, "Oh, so as to be about." A great many of us today, although perhaps we don't acknowledge it, think we are all right if we are able to be about—if we are able to come to class and do the ordinary material things—"Oh, I am very well." We ought to have within us a sense of spare energy, a force of abounding vitality. We ought to wake up in the morning and be glad there is a new day coming. We ought to feel the force and energy ready for work. That is the first test I think we should apply to ourselves. (I don't know of any outside mechanical test.) We ought to feel glad that we have a day's work to do. I should be very much afraid to ask this audience to rise—those who do feel that every morning.

We ought to feel the ability to do. Perhaps that is the best way to put it. Often a person does not really feel competent, but he makes a bluff of feeling competent. The student comes up to examination on a bluff sometimes. He does not really feel competent. I am very suspicious of a student who says he sat up till one o'clock studying. He is putting up a bluff. He does not feel conscious of his ability to go to that examination.

When you go out into the world that sort of thing will be found out very quickly. The world is a very severe task master. A person finds his level very quickly, no matter what it is that one is trying to do We have inefficiency in a great many cases and in all lines it is a growing evil. Now, say what we will, an examination is, I think, a very good test, because it shows you have your power in hand. I know there is a great objection made to examinations. But even if you think you know your subject well, it may be doubtful in the teacher's mind whether you can use it in an emergency, which is what an examination tests. Of course, I mean a good examination. We need some test which we can apply to ourselves.

It has always seemed to me that the great educational value in the schools of manual training was that you did not need the teacher to tell you whether you were right. If you are trying to make two pieces of wood fit together, and you hold them up and see the light between, you know you haven't done it, and you don't need your teacher to tell you it isn't right. In ordinary school work you have a feeling of dependence on somebody else, whereas in the manual training idea you depend upon what you see yourselves. We should find in ourselves a test of our ability to do. I do not know what form it is going to take. I have not a new word to give you, except the word we use in electricity—efficiency.

Whatever we do, each one of us must have a certain ideal for our own force for magnetic power. I believe that is what we must aim for, a certain reserve power. How are we going to get it? Where is it going to be made? It must be developed in the young person. It must come from the home and the home training. That is the place where we must begin. The habit of allowing children to grow up in

any kind of way, eating just what they like, and playing if they like, and studying if they like, may seem very nice to the children, but it does not give them the right sort of habits. I think that our efficiency is coming very largely from the habit of life, and that must be formed in the home. That is why we are laying great stress today on teaching home economics—because we believe that sanitation, that healthful position, that these habits of breathing that I speak of, that all the regulation of food, and the habits of eating food, and of sleeping (sleeping is a habit, very largely, that is, a good, sound, dreamless sleep) all come into play in developing this material machine of ours. This material machine is manufactured in our homes, and it is there that the knowledge of these things must penetrate. Love is all right, but it is not today enough to keep a house, as many a woman can testify who has lost her children.

We believe that it is to the homes of the land that we must bring all the sciences we can muster, and we want the young men who are going out today to bring their inventive power to bear on improvement in daily life. Many an invention has been made for the home which has not been used for the home. The people weren't ready. The women threw the inventions on the dump heap, and the men got tired of makking them for us. But the time has come young men, when we will take almost anything you will give us in the way of help. And also these students who are going out from the course in home economics are willing to carry that idea still farther. That is why I rejoice in your co-operation. And I count on that mutual help as being a model for many other schools, because it is in this line that we need the very best that we can possibly have. It is the better living conditions which render possible the truer production of human energy. And the most valuable form of it is what we turn out from our schools—the creating, the organizing ability, that which combines and controls all other forces.

Where the first model homes are going to be for turning out these leaders I do not know, but I hope that each and every one here will add something; and perhaps the initiative will be taken by some of these students who are going out today from us—and that in a year or two we may find the ideal which we are seeking. As I said at first, the students need friends today more than ever before. We need friends along this line to encourage and to support the experiments which must precede the perfected invention.

I am sorry to say that we have pushed our work in home economics against the greatest resistance on the part of the public. The ordinary housewife thought she knew, and she did not like to have us upstarts tell her she did not know, and we have to work under great difficulties. The scientific man thought we didn't know how to apply science, and that we wouldn't apply it if he told us. And so on. It has been under great difficulty, but I believe the time has come when we shall see a very rapid advance. And I hope that you will all go away realizing that the future of America does not lie in railroads or machines, but that the future of our republic is to be determined by the character of the American homes.

AMBITION.*

By Winder Elwell Goldsborough,** M.E. (Cornell.)

"Give us! Oh, give us, the man who sings at his work."

When I came to your city yesterday and took a drive around through the beautiful shade trees and lawns, and up and down along your splendid Raquette river, I felt, "Oh! how great a thing it is to have been a student in such a place."

One never realizes until one gets out into life what the building up of the years of youth means. If you have pleasant pictures to look back upon, if you have pleasant thoughts to live with in the years that come, it is easy then for a "man to sing at his work."

We have a great misconception of what "work" is. When I was a boy work meant discomfiture to me. I always heard work or labor spoken of as something that no one wanted to do.

Now, there are various definitions to be given to work, and the generally accepted definition of work is wrong. To my mind work is any agreeable and at the same time useful thing which a man has to do. The thing which he wants to do. It makes no difference what that thing is. If you are kept from "work" or tasks which you wish to perform by the obligation resting upon you to attend social functions, then these social functions become hard to endure. Many times a social function is a real bore, and there is no pleasure in it.

But, are there many of us here who have not felt the thrill that comes with the perfecting of some one thing in which we have had our heart? What young engineer, after he has created through his plans, designs and work, a large engineering plant, would be willing to be absent from the starting up of that plant for any social function or any pleasure of field or sport which you could offer him? It is the essence of his success. His life blood has gone into the plant. It is a creature of life and being to him. And he would not give up the pleasure of being there; of working all night; of experiencing any discomfort to make that plant a success, for anything else you could give to him.

It is not the money, it is not the gain, which makes men in this country. America has been accused of being a country in which only gain is sought. That is not true. I have come in contact with too many of our men; I have seen too many of our boys; I have had them work too close to me to ever for one moment think that the dominant idea in the brains of our men and boys is money.

I have lately come to live in New York. What tales you hear of Wall Street! The country has been ready to think that Wall Street is a base place where men have no thought except of themselves and of other men's possessions which they would claim. In some measure that is true. It is true in Potsdam. It is true all along the banks of the Raquette river. It is true everywhere. There are selfish people everywhere. There are people who are always willing to take advantage of their fellow men. But this is not true on Wall Street in any greater measure than it is anywhere else. The density of population

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**Vice-President, American Institute of Electrical Engineers; with J. G. White & Co., New York City.

during business hours on Wall Street is enormous as compared with the density of population here,—and a small selfish act here is as big, relatively speaking, as a grossly selfish act on Wall Street, because the concentration of forces there is so much greater. But if you go on Wall Street and meet the men who work there, and get down into their lives, you will find many a man who will refuse point blank to enter into any transaction with any man who is not known to be fully honorable and above taking a mean advantage of his fellows.

And when it is said that our men are not measuring up to their full stature in this country, and are not meeting the demands that are made upon them, I challenge that statement. I do not think it represents the enlightenment to which we have come.

Look at the homes of this country! Look at the men who strive to make those homes pleasant and agreeable! To lift the burden of care from the housewives and mothers and sisters. See what a showing has been made. No nation compares with us. And yet, can it be said that our men do not rightly measure up to their duty?

I want to talk today, not so much about the past and the college, as about the future that lies before you who graduate and will go out into the world.

Before I went to college, I had the feeling that commencement day initiated a sort of vacation, and that when I reached it all work would be over, and afterwards there would be very little left for me to worry about. Now, I think a great many young people have just that idea. You may think that idea is a fine idea, and I, indeed, wish that every young man and every young woman would make commencement day the end of all care and all trouble.

What does that mean? It means that they would then take up life and the duties of life without worry, without hindrance of mind, and with bodies well balanced and trained. That they would bring the lights and shades of life into harmony with their surroundings. That they would be a joy to themselves, and a much greater joy to their friends.

People say you must worry, you must bother yourselves with the exigencies of life. You must carry a burden whether you would or no. I think that is wrong. I used to take a great deal of pleasure in watching my grandfather. He was a physician, and, at the time I speak of, a man about eighty-four or five years of age. He stood erect walked with elastic step, and was in every sense of the word a man. To the very day of his death he was active, and no one thought on the day that he died that he would not live to be a hundred. I well recall on one occasion when a boyhood friend who had been close to him all his life lay very, very sick with pneumonia. His life was almost despaired of. And my grandfather was working as few men ever work to save his life. He would leave him, after working over him for six or seven hours, go home and lie down on a bed, and in a moment was asleep; and sleeping as peacefully as anyone, unburdened by the least care or responsibility, could hope to sleep.

Now, if we can all make ourselves sleep in that way in hours of stress and anxiety, we will open to a new page in life. Often when confronted by a difficult task, we think about it after going to bed; sometimes we thing about it persistently, and sometimes we do not get to sleep at all.

Take my word for it, and train yourselves, as the best asset you

can possibly acquire, so that when you go to bed you can quit thinking and go to sleep. The first time it will be hard, the second time it will be pretty nearly as hard, but by and by you will be able to sleep standing up if you have no opportunity to lie down. Sleep is a great thing. It stimulates and energizes a person, and helps wonderfully to free one of care.

When we go out from college and enter commercial life, the first thing which we all strive for is to secure a place in which to earn our living. And what is the attitude which you should have toward your first place? My idea is that a young engineer, or any professional person, when entering upon a new position should take things very quietly. He is not supposed to know anything. The college man is never supposed to be very learned, so why should he try and make people believe what beforehand they have decided not to believe. Isn't it very much better to allow them to think you don't know very much, and they won't expect very much of you, and if they don't expect very much of you, you certainly ought to be able to meet their expectations.

It is a very good thing to keep quiet and let the other man in the plant tell you as much as he will about it. And after that, compliment him upon the condition of his plant. If you find little things you believe can be improved, overlook them. He has put his time and such knowledge as he has into the plant, and, if he is worth the name of man, he believes in the plant. It is only kind and only generous and only considerate to compliment him on anything you can compliment him on about the plant. Then draw out of him all he knows in addition to what he has previously told you. And by and by you will get to a point where he has told you everything he knows about the plant. Then you have him at a disadvantage. You know what he knows, and he doesn't know what you know. And you have him at a disadvantage at once; because you can always under such conditions at least do some one thing a little better than the things that he has done, and there your credit account opens. By and by, by perseverance, possibly a little study outside of the station house, you can do one thing else, and you have one more item to your credit. Don't get anything on the debit side of the ledger. By and by you will take as much pride in that account as a banker takes in his cash account; and you will be considered a safe man in that plant. It is worth any man's time to wait two or three years, if necessary, just to gain the reputation among a lot of men, among a lot of people who have really been in the battle of life, of being a safe man. It will follow you as long as you live. If you get the reputation of being an unsafe man, it will just as persistently attack your steps. Be a little jealous and very modest—jealous of your reputation and modest of your personal qualifications, and you will have learned something which will be of great value to you as you go along.

There are many things which a young man has to learn if he would succeed, and all of us want to succeed. If we could only, when we start out, have the knowledge of the ways and methods of mankind that we acquire in later years, it would be very valuable to us. We can't learn those things by having them told to us, because they somehow slip away. If you visit an engineering structure and study it, you can always carry it in mind and remember it, and have it as a direct asset; but if you only learn of it by hearsay you may or may not be

able to retain a memory of it. And so it is with experience. We must learn it at first hand. We must acquire it for ourselves. Then why should any young man be willing, during two or three or four years of his life, to stay in one shop and learn but one thing, when there are so many things to learn?

I once was talking with Dr. Robert H. Thurston. I had been out of college about three years, and in talking over the situation with him I apologized, because the old saying, "A rolling stone gathers no moss" did not seem to be exemplified in what I had been doing, as I had changed my position several times in the three years. He said, "Don't worry about that. A rolling stone is the only one that gets polished." That set me to thinking. If the rolling stone gets polished—if you want a high polish, you have to roll a good deal.

So the thing for a young man to do is to get out in life and to learn all he can in one position, and then, as soon as he has acquired the better part of the knowledge of one—he is young—he ought to break off, and get another place, even if he has to begin all over again. Because,—think of the experiences he is going to get in the new place; the new problems he is going to have to solve, and he will be twice as good a man when he has acquired the new experience.

Make trouble for yourselves, or at least what the world calls trouble; and with deliberate aforethought, if need be. Change conditions around. You have but so many years to live. And before you are thirty years old you must acquire a great deal of information about the ways in which business is and can be done. You note that a certain man has consolidated a number of properties and thereby accumulated great wealth. How was that man able to do it? Once that man was in the same position you are. How did he find out how to consolidate properties? By going and consolidating something. And he built and he built, and he consolidated bigger things, and by and by he became a multi-millionaire—and you wonder how it all happened. Simply because that man had the energy to go and find out the ways of doing these things and then to do them, and not necessarily, at all, because he had the means at hand with which to do them. No man who has attained to fame or to wealth by his own work, has attained to it except with much the same foundation and much the same opportunity that you have.

There is only one difference between a rut and the grave. The rut is longer and narrower. So get out of the rut.

Now, a great many people think it is difficult to foretell what will happen; and it is in fact quite difficult to foretell what will happen. But it is a matter of great importance to any man who is mindful of his future to learn to forecast what will happen. Every successful man in this country can, I believe, draw a very accurate picture for you of what will happen in the next two or three years in the field of work in which he is engaged. If things are running smoothly about him he knows they will continue so tomorrow. Presumably he has persons around him who will look after the details. It is for him to think and to look ahead, and not merely to be satisfied with things around him as they are.

If a man would be sanely ambitious, to my mind, it is absolutely wrong for him to say: "In time I will occupy such and such a position." Why? Because he will then have his heart set on a particular place; and what if he never attains to it? He will always be a man of em-

bittered feeling. That is very unpleasant. It is unpleasant for the man, and much more unpleasant for his family and friends.

To be the best type of an ambitious man, it is necessary that every young man should look about him and see for himself what is required of him as among his fellows. Who, then, of the world are his fellows? They are the men who then occupy the same position in life as himself. Of all the people in the world very few of them can be great. Therefore, if we are level headed we ought to decide once for all that come what may we will be satisfied. To make up our minds beforehand that we will be perfectly satisfied and contented if we never do any better than the average man in our (then) station of life. Why? Because the average man in our station of life will live and die in that station, in all probability. That is the history of the world. Think of the millions of people there are with very little accumulation of any kind as gaged by the standards of the world. So make up your minds beforehand to be satisfied. Then start out and try and get your head a little bit above your then level—your level as gaged by attainment. As soon as you have risen above that particular level you have gained a point. You have made a step forward in your ambitious life. You have raised yourself to a new field of view. You are learning how and it should be easy for you to step from the new field to another, because you can easily see a little way ahead to the position into which you wish to lift yourself. You can sight it even though at a distance, and when it finally comes to you, you are prepared for it. You can step into it on an equality with the men of the new level.

You have the opportunity now of looking ahead once more. You can gradually accumulate, until you progress. You always feel contented, because in each step you make forward you have gained something to be desired. You have no ambitions left unfulfilled, because your ambitions of the past are already accomplished.

I think it is well that every man should learn, among other things, what it is to be an optimist. Not that we should not have men in the world to hold a good check on it. They are just as necessary as are the men who are radical. But even the men who are conservative can consistently be optimists. The difference between the optimist and the pessimist is that the optimist sees the doughnut and the pessimist only sees the hole. Now, how much better it is to be an optimist, and to have something to look forward to.

When one of your subordinates comes in and tells you a hard luck story, (that something has gone wrong in the plant, etc.) what should be your attitude? Ought you to "jack him up" for being an inefficient engineer? Ought you to make him feel he is discredited among his fellows? Not by any means. Have the men who report to you feel that there is just one man on earth who will take off his coat and do anything under Heaven to help them out of a hole and keep the other fellows from knowing about it. What will then be the result when you call on your "Boys!"? Every man will step up and be ready to come in behind you and support you in any emergency. You have the confidence of your men.

I have heard a young man who went to the Philippines tell of an officer who fell in battle, shot in the back by his own men. Think what that means! In the judgment of the men he commanded he deserved to die; and when he got out in front of his company, the men

shot him. Why? Because that officer had made every man in his company get over a stone wall, instead of going through a hole under it, right in the face of a galling fire; and after he had ordered fifty men over the top of the wall he crawled through the hole himself. Think of it! Did not that man deserve to die? He ought to have had his men go through the hole and have climbed over the top of the wall himself. He would then have gained their respect.

Because I have the right to order you into a position of danger, is that any reason why I should needlessly do so? If there is anything to be gained by my going into a position of danger, it is my duty to go at once, because in so doing I stimulate you to finer and superior action. Remember that with your men. Have your men feel they can come to you and talk to you freely. And when you have a hundred men working for you, and not one making a murmur, you can cock your feet up on the desk and feel just as fine as you please. You know your men are measuring up to their duty. There is no need for anybody to worry. You can take a vacation. You can go out into the open where the sun is shining, and you can see there again the green and the gold made by God, and thank Heaven that you have had the opportunity of being in these halls and of mingling with these people, and of learning here the foundation of a useful and successful life. (Note. The Clarkson colors are green and gold.)

It is a great thing to be a helpful person in the world. It is a great thing to have a fellow come to you and say "I appreciate the fact that you helped me over such and such a place." Possibly you don't remember about it. But it means a great deal. If you have the confidence of your men, you have the confidence of your employer. If you have not the confidence of your men—I mean the men that report to you—you have not the confidence of your employer.

Not long ago I heard a gentleman who is in control of a large business say in speaking to the head of a department: "Why, look at so and so's department; I don't know it is there. I never have to worry about it. Reports come in; they are good; they are represented by a big sheet of paper laid on my desk every once in so often. That is the only thing I know about that department."

If you go to a busy man and start out to read him a long report he will stop you. "What is the answer?" That is what he and people generally will want from you. They don't care about your difficulties or how hard it has been for you to do a thing. But, have you got the answer? Never tell a hard luck story. It doesn't make any difference how hard it has been, how you have slaved, burned your hands or blistered your feet,—don't say anything about that. Have you got the answer? If you have a good answer they will let you tell the story of that answer to your heart's content. That is where the joy comes to you. That is your reward.

If you have been helping some other fellow along in a difficult situation—and many men in this country have to help others—which would you prefer? Would you prefer he should come and thank you once in so often, and feel he was slipping back constantly? Or would you prefer to have him say nothing to you about thanks for what you had done, but always be right up to the level, winning his way? Are there any thanks that can be so sweet to you as these silent ones?

Put yourself in the other position. Remember the people to whom you turned, who have helped you. What is your duty? What

is the thing that will make them happy? It is by measuring up to the point where you pass their expectations and stick your head over the imaginary line of success, a line not well defined, but well known. No one can succeed without it being noticeable. As soon as you get up to the "success line" the whole atmosphere about you changes. You are a prosperous man.

It means a great deal to win confidence and good will. It means everything.

You have all been here, women and men alike, studying to perfect yourselves in technical and scientific knowledge. And what is the value of technical and scientific knowledge? Technical and scientific knowledge must be held in a proper esteem—an esteem recognizing in them potency to help us over the difficult places.

No one of you who goes out into life will have any great occasion in all probability to call on either science or technology. It is a fine thing to know how to solve problems in higher mathematics. It is a fine thing to know how to detect deleterious microorganisms. It is a fine thing to know both. But you don't have to use such knowledge every day. You can be just as happy, and just as careless, and just as joyous, even though you do know all these dreadful things. You don't have to use them every day in life.

I feel that success in life, in engineering life, in any life, is made up of about nine parts common sense and one part scientific and technical sense. To my mind science and technology are the army and the navy of success. You want to have the army and the navy always ready. In that army and navy, which we will say represents ten per cent. of all available forces, you have a few well developed specialties. They are your thirteen inch guns. The heavy ordinance for pounding away upon the strongholds of knowledge, the artillery that open to you new paths. You want to have them ready so you can call on them when they are needed. There will only be a small number of times when you will have to call on them. At the same time when you need them you will need them just as truly as do men in battle.

The victories of peace, to my mind, are far greater than the victories of war, and if any man can devise a means for making the people of the earth live in peace and harmony, and do away entirely with the need of manufacturing arms and explosives, he will be far greater than the greatest general who ever lived.

I will admit there was a time when I enjoyed going out and shooting game, going out and shooting birds, just for the sake of shooting. I didn't want the game, hadn't anything against the birds—I simply went out to shoot them. I was guilty of murder in a modified form, sanctioned by custom, but nevertheless brutalizing to a degree. And since that time I haven't cared a bit about shooting, or fishing or molesting life in any wise where it was of no advantage to me and of no benefit to anyone. It is a great deal finer, to my mind, to go out on a tennis court and use your brains and your muscle in an equal contest with an adversary, even though the contest be a peaceable one, than it is to go out, knowing you are a giant, armed with weapons, to destrop creatures which God has made (and which we can never approach in our creations), all for the love of killing. It is well worth thinking about. And the man who thinks about it a little while, and reads about a few massacres in Armenia, and a few Russian riots, will reach a point where he will find very little pleasure in that kind

of activity, and feel there is a great deal more to be gained by turning toward the simpler and more normal pleasures of life, and in exerting his energies where they will always be helpful.

A gentleman came to my office a few days ago, and, after talking about a few matters of business, got a little side tracked. "Now," he said, "you know I have one of the best wives in the world. She lives there at home. (I have a nice home out in Michigan, and I have a nice family of children.) I believe it is my duty to her when I go home to notice how she is dressed, and tell her she looks well, or notice something about the house, and let her see she has my sympathy and that I appreciate the things she has tried to do. When I accomplish those things, I believe then that I have accomplished a great deal, and something that is much more worth while than the things I do down town."

The movement, which has gained a place in America, of giving women scientific and technical training, in kind like to that the men enjoy, is a great thing. I believe among the best assets I have I derived through learning the blacksmith's trade, the carpenter's trade, and the founder's trade. Why? I don't expect to be a founder or a carpenter or a blacksmith, any more than I want my wife to be a cook or a seamstress or a washer woman; but I do want my wife to know how, so that the washer woman can't do inferior work and make a flimsy excuse for it; and as for myself, so that a blacksmith can't do a bad piece of work and make a flimsy excuse for it. It isn't right that we should condone the too prevalent present condition of things. No housewife should be afraid to give instructions to a domestic,—and there are many housewives in this country who are afraid to give instructions to domestics, because they don't know what instructions to give. The domestic is running the house for them to to all intents and purposes.

I once had a very interesting conversation. It occurred at one of our club meetings, this club being designed to bring men and women together, the membership being taken from both sexes. And during a lull in the proceedings, in some way we got into a conversation about where the different meats come from. Well, it was quite evident that lamb comes from lamb, and that a lamb chop also comes from lamb. But where did mutton come from? That was a real poser. Where did pork come from? Finally, however, we got to a point where some one wanted to know where veal comes from. One lady said, "Why, yes, of course, veal comes from venison." This may be an exceptional case. It is, however, absolutely true, and those ladies were all members in high standing, of that "very literary" club. I have often wondered since if any of them are able to tell whether a fowl is fat or lean before its feathers are picked.

The technical and scientific training of women is going to have a great deal to do with the improvement in health of the families of this country, and too much stress cannot be put upon this point. I feel it is very important indeed that the young married women of this country should be trained. They should be regarded as professional people just as much as women who study law or medicine, or any other of the learned professions. A woman who is a married woman and at the head of a household should be regarded as engaged in the most important professional occupation this country has to offer.

I hope in this school in the last two or three weeks you have all

had to pass real hard head-splitting examinations. Why should I hope this? Because of the things a man or woman has to confront during a college course, when the last word is said, the examination is the best of all. Why? Successful men in this world tell us they often have to focus themselves. They have to prepare to meet some emergency. They have to go down into books and fill themselves with the particular things they teach. They have to load themselves with the knowledge of special facts and principles until they feel that if they can't unload they will go to pieces. They prime themselves up to the top notch. At a certain time they must deliver the stroke. They are ready for it. They have their forces together. They bring forward every item of truth or fact that can be brought to bear upon the point.. They urge and force and strive and do the thing.

It is easy to do the things that other people want you to do. But it is sometimes hard to do things with every known force apparently locked against you. And yet it is done. The world knows it is done. Every person knows it has been done, whether it be done under fire in battle, under fire in engineering, or under fire in business.

There are times when the nerve fibre—the brain force—becomes the dominant factor in human affairs, and accomplishes greater things than all else besides—whether it be of brute force, of skilled labor, of automatic machinery, of controlled natural forces, or of untrammeled outbursts of the elements.

There are times when one little brain cell has, through the strivings of a constant and determined nature, been brought to such a state of perfected intensity as to flash forth through the personality of a fervent spirit and in an acute moment bring to pass an almost superhuman result. Such perfection is the product of a forced concentration of the brain and is man's highest tribute to the Maker of Men. To my mind such perfection marks the essence of God in man. Man is most nearly Godlike when he reaches one of those apexes.

The thing that engenders this evidence of power in you is the preparation for and the test of the examination. It causes you to take stock of and harbor all your forces.

When the examination is over—the time of stress past—throw off the accumulations of your learning. Get rid of them. Run right out and be free. Be a boy again. Get rid of the stuff. Why? Because then you will have your mind free, as free as the air, and when the next problem comes you can tackle it with the old vigor.

If a man is a man I don't ask him when he gets up in the morning, but when does he go to bed. That is the test. If a man goes to bed at three o'clock in the morning he does it for one of two reasons. It is for a base purpose or a useful purpose.

"The heights by great men gained and kept
Were not attained by sudden flight,
But they, while their companions slept,
Were toiling upward in the night."

There is no truer saying. There is nothing that will make you men feel better, and you women feel better, when you accomplish a hard task, than to think that thought.

You will find as you grow older that the sweets of success are not over sweet. When you entered here as freshmen, you thought—"on commencement day I will be a senior and I will get a diploma and how fine that will be."—but I venture to say that every man and woman

who gets a diploma today will realize that he or she is in a new class, that the diploma is a certificate of another plane, that a new life is ahead. that new problems are to be solved, and that after all, the diploma will soon be but a matter of history. Sweet at "commencement", but after all only a matter of history.

I once read a book dealing with one of the great problems of life, and through that book ran, ever recurring, a bar of music, chimes; and as the story progressed those chimes came ringing out from the old church tower:

"He watching over Israel, slumbers not, nor sleeps."

Deep down in your hearts, all unconsciously to you, those chimes are ringing. Every man among you, and every woman among you, has the problem to work out, and a history to make, of a human life. Every one of you is intrenched in the love and affection of your own people, many of whom are here today, proud and happy, to see you graduate. And here you will and do resolve to guard your own, to advance along the right way, and to win—God help you—the only success that really meets the full measure of a worthy ambition—the esteem, honor and praise of one's own people. Be men and women in the full sense in which your hearts and minds interpret those words, and you too will hear ringing, ever ringing out the chime—

"He watching over Israel, slumbers not, nor sleeps."

APPOINTMENTS.

The following appointments have been made by the Board of Trustees, to take effect September 1, 1906:

Mildred Mae Parker, B.S. in Home Economics, to be Assistant in Home Economics.

Floyd Ray Finch, '07, to be Tutor in Mathematics, vice Francis Patrick Cummings, '06, graduated.

Charles Duane Owen, '07, to be Librarian, vice Arthur Bender McIntyre, '06, graduated.

David Dittmar Thomson, '07, to be Assistant in Surveying, vice Frank Heath Flint, '06, graduated.

SEVENTH ANNUAL COMMENCEMENT.

The public exercises attending the Seventh Annual Commencement began with the Baccalaureate address in the Chapel Hall, on Sunday, June 10, 1906, at 2:30 o'clock in the afternoon. The address was delivered by the Rt. Rev. Richard Henry Nelson, D.D., Bishop-Coadjutor of Albany. The following program was rendered:

PROGRAM.

Hymn—"Holy, Holy, Holy, Lord God Almighty".. .. ..Heber

Prayer.

Music—"Intermezzo".. .. ..Mascagni
Welker Orchestra.

Scripture Reading.

Hymn—"All Hail the Power of Jesus' Name".

Address:
"Workers Together With God,"
The Rt. Rev. Richard Henry Nelson, D.D.,
Bishop Coadjutor of Albany.

Hymn—"Onward, Christian Soldiers".. .. ..Baring-Gould

Benediction.

The Commencement was held in the Chapel Hall, June 15, 1906, at 10 o'clock in the morning. Addresses to the graduating classes were delivered by Ellen Henrietta Richards, A.M., S.B., Instructor in Sanitary Chemistry, Massachusetts Institute of Technology, and Winder Elwell Goldsborough, M.E., of J. G. White & Co., New York City:

PROGRAM.

Overture—"It Happened in Nordland".. .. ..Herbert
Welker Orchestra.

Invocation.

Address:

Wanted, a Test for "Man Power."
Ellen Henrietta Richards, A.M. (Vassar), S.B. (Massachusetts Institute of Technology), Boston, Mass.

Serenade—"Moonlight".. .. ..Moret
Welker Orchestra.

Address:
"Ambition,"
Winder Elwell Goldsborough, M.E. (Cornell),
New York City.

Waltz—"The Tenderfoot".. .. ..Heartz
Welker Orchestra.

Awarding of Certificates.

Conferring of Degrees.

Benediction.

March—"The Clarkson Favorites".... .. ....Arr. by S. S. Stone, '05

DEGREES AND CERTIFICATES.

Degrees Conferred, Certificates Awarded and Subjects of Theses Presented for Graduation, Seventh Annual Commencement, June 15, 1906.

Degrees.

Bachelors of Science in Civil Engineering.

Carl Christian Ahles,.. .. ..Redwood, N. Y.
Frank Heath Flint,.. .. ..Parishville, N. Y.
Joint Thesis: Discharge of Racquette River at Potsdam, N. Y.
Roger Dean Flint,.. .. ..Potsdam, N. Y.
Thesis: Plan and Design of a Hydro-electric Power Plant at Colton Falls, N. Y.
Abel Farrington Simpson,.. .. ..Potsdam, N. Y.
Thesis: Design and Proposed Layout for Railroad Station and Yard Facilities, at Potsdam, N. Y.

Bachelors of Science in Electrical Engineering.

Robert Jay Burrows,.... .. ..Youngstown, Ohio
Thesis: Experimental Determination of Permeability at Low Densities.
Francis Patrick Cummings,.. .. ..Raymondville, N. Y.
Ralph Burton Leonard,.. .. ..Malone, N. Y.
Joint Thesis: A Study of the Operation of the Hannawa-Ogdensburg Transmission Line.
Arthur Bender McIntyre,.. .. ..Webster, N. Y.
Thesis: Comparative Study of Design and Construction of Long Distance Transmission Lines.
Francis Long Perkins,.. .. ..Potsdam, N. Y.
Howard Sanford Phelps,.. .. ..Moravia, N. Y.
Joint Thesis: An Experimental Study of the Effects of Interrupters upon the Action of Induction Coils.

Bachelor of Science in Mechanical Engineering.

Ceylon Roy Cady,.. .. ..Brushton, N. Y.
Thesis: The Testing of High Speed Gasoline Motors.

Bachelors of Science in Home Economics.

Irma Hale (B.S. St. Lawrence University, 1903, A.M. St. Lawrence University, 1906),.. .. ..Canton, N. Y.
Thesis: A Study of Bacteria in Relation to Home Economics.
Mildred Mae Parker,.... .. ..Morrisville, N. Y.
Thesis: Food Adulteration.

Certificates.

For Two Year Course in Home Economics.

Sarah Edna Bush, ...Canajoharie, N. Y.
Thesis: Domestic Science in the Rural Schools.
Corinne Marietta Frame,.. .. ..Clayton, N. Y.
Thesis: Common Household Insects and their Extermination.
Ruth Mabel Hungerford,.. .. .. Evan's Mills, N. Y.
Thesis: A Dietary Study Conducted in Potsdam.

ANNOUNCEMENT.

September Examinations for Matriculation. Academic examinations for matriculation in the Thomas S. Clarkson Memorial School of Technology will be held in the Institution, in September, of each year, under the rules and regulations* of the New York State Department of Education, and under its auspices. These examinations are set according to the following daily program for 1906:

September 17 Monday 9.15 a. m.	September 18 Tuesday 9.15 a. m.	September 19 Wednesday 9.15 a. m.
Advanced arithmetic Rhetoric German, 1st year Latin, 1st year Algebra, elementary American selections	Elementary English German, 2d year Plane geometry Physics Elementary United States history and civics	German, 3d year Arithmetic American history and civics Stenography Caesar Geography Latin grammar Elementary Latin composition
1.15 p. m.	1.15 p. m.	1.15 p. m.
English, 1st year, 2d year, 3d year Advanced English English composition Botany, elementary Roman history Psychology and principles of education	French, 1st year Spelling English selections Physiology and hygiene Economics Bookkeeping, elementary Chemistry	Physical geography History of Great Britain and Ireland Civics Drawing History and Principles of education

Candidates seeking admission to these examinations, whether with view to entering the Institution, or to make up academic conditions, after entrance, should make application of the Director, at least ten days in advance, stating at what time and in what studies they wish to be examined.

The eleventh year of the Clarkson School of Technology opens Tuesday, September 11, 1906.

*State of New York Education Department, Handbook 3, Examinations 1905-10; Examinations Division, State Education Department, Albany, N. Y.

Thomas S. Clarkson
Memorial
School of Technology
Potsdam, N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language, literature and history, mathematics, the natural and economic sciences, engineering and technology. The instruction is largely taken in common, during the first two years, and provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of the applied sciences, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting investigations.

The technical instruction of the last two years, in theory and practice, affords substantial preparation for immediate usefulness after graduation by intelligent application of principles to the successful mastery of the details of the chosen field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their profession.

The four year courses in engineering for men afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical or mechanical engineering. The four year course in home economics for women offers a full college training, whose aim and scope are to prepare for teaching home economics, as well as for the efficient management and supervision of the home.

These courses of instruction lead to the degree of Bachelor of Science in the major subject pursued; namely, chemical, civil, electrical and mechanical engineering and home economics. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

CLARKSON BULLETIN

Vol. IV. APRIL, 1907. No. 2.

THOMAS S. CLARKSON
MEMORIAL
SCHOOL OF TECHNOLOGY

POTSDAM, N. Y.

ISSUED QUARTERLY BY

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY

Entered January 16, 1904, at Potsdam, N. Y.,
as second-class matter, under Act of Congress,
of July 16, 1894.

1907

Clarkson Bulletin

Potsdam, N. Y.

Issued Quarterly by
Thomas S. Clarkson Memorial School of Technology.

1907

CLARKSON BULLETIN

Vol. IV. APRIL, 1907. No. 2.

CONTENTS OF THIS NUMBER.

Contents of Clarkson Bulletin, Vol. IV., No. 1, Supplement.

Contents of Clarkson Bulletin, Vol. IV., No. 1.

Announcement: The Clarkson Bulletin is published quarterly January, April, July, and October, each year.

It will be mailed upon application to

The Director,

Clarkson School of Technology,

Potsdam, N. Y.

CALENDAR

1907-1908

II. Semester, 1907.

Jan. 28, Monday	Instruction begins.
Feb. 12, Tuesday	Lincoln's Birthday.
Feb. 22, Friday	Washington's Birthday.
March 19, Tuesday	Charter Day.
March 28, Thursday (evening)	Spring recess begins.
April 9, Tuesday	Instruction resumed.
May 30, Thursday	Memorial Day.
June 1, Saturday	Day for depositing theses in library.
June 9, Sunday	Baccalaureate Sunday.
June 10, Monday	Semester examinations begin.
June 12, Wednesday	Annual meeting of Trustees.
June 13, Thursday	Examinations close.
June 14, Friday	Eighth Annual Commencement.

I. Semester, 1907-1908.

Sept. 10, Tuesday	Registration of matriculated students. Matriculation of new students.
Sept. 11, Wednesday	Instruction begins.
Sept. 25, Wednesday Sept. 26, Thursday Sept. 27, Friday	Academic examinations for candidates for matriculation, under auspices of New York State Education Department.
Nov. 9, Saturday	Mid-semester. Last day for announcing subjects of of theses for baccalaureate degree.
Nov. 28, Thursday	Thanksgiving Day.
Nov. 30, Saturday	Founder's Day, Eleventh Anniversary.
Dec. 11, Wednesday	Semi-annual meeting of Trustees.
Dec. 21, Saturday (noon)	Christmas recess begins.
Jan. 2, Thursday	Instruction resumed.
Jan. 23, Thursday	Semester examinations begin.
Jan. 25, Saturday	Examinations close; end of I Semester

II. Semester, 1907-1908.

Jan. 27, Monday	Instruction begins.
Feb. 12, Wednesday	Lincoln's Birthday.
Feb. 22, Saturday	Washington's Birthday.
March 19, Thursday	Charter Day, Twelfth Anniversary.
March 28, Saturday	Mid-semester.
April 16, Thursday (evening)	Spring recess begins.
April 28, Tuesday	Instruction resumed.
May 30, Saturday	Memorial Day.
June 1, Monday	Day for depositing theses in library.
June 7, Sunday	Baccalaureate Sunday.
June 8, Monday	Semester examinations begin.
June 10, Wednesday	Annual meeting of the Trustees.
June 11, Thursday	Examinations close; end of II Semester
June 12, Friday	Ninth Annual Commencement.

OFFICERS OF INSTRUCTION

William Sleeper Aldrich, M. E.,
Director

Frank Marion Williams, A. M.,
Professor of Chemistry

Walter Scott Graffam, B. S.,
Superintendent of Shops

Byron Briggs Brackett, A. M., Ph. D.,
Professor of Physics and Electrical Engineering

Carl Michel, A. M., Ph. D.,
Professor of Modern Languages

Myra Brewster Clarke, A. B., A. M.,
Professor of Home Economics (1905-1907)

Frank Robinson Swift, S. B.,
Professor of Mechanical Engineering

Donald Fraser McLeod, C. E.,
Professor of Civil Engineering and Mathematics

Mildred Mae Parker, B. S.,
Assistant in Home Economics

Floyd Ray Finch, '07
Tutor in Mathematics

David Dittmar Thomson, '07
Assistant in Surveying.

Charles Duane Owen, '07
Librarian

Thomas S. Clarkson
Memorial
School of Technology

(Copy of the original charter.)

UNIVERSITY OF THE STATE OF NEW YORK

CHARTER OF

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

Whereas, A petition for incorporation as an institution of the University has been duly received, and

Whereas, Official inspection shows that suitable provision has been made for buildings, furniture, equipment and for proper maintenance, and that all other prescribed requirements have been fully met,

Therefore, Being satisfied that public interests will be promoted by such incorporation, the Regents by virtue of the authority conferred on them by law hereby incorporate

Elizabeth Clarkson, Frederica Clarkson, Annie Clarkson, Abraham X. Parker, John G. McIntyre, George H. Sweet, Edwin A. Merritt, and their successors in office under the corporate name of Thomas S. Clarkson Memorial School of Technology with all powers, privileges and duties, and subject to all limitations and restrictions prescribed for such corporations by law or by the ordinances of the University of the State of New York. The first Trustees of said corporation shall be the seven above named incorporators. This corporation shall be located at Potsdam, St. Lawrence County, New York, and may grant diplomas to all students who complete the regular courses of instruction, and certificates to those completing special work. All graduates who shall have satisfactorily completed the course of study and the examinations required and shall have been recommended by the Trustees for the degree of Bachelor of Science, shall receive from the University the degree B.S. certified by a diploma bearing the seals and the official signatures both of the institution and of the University of the State of New York.

In witness whereof, the Regents grant this charter No. 999 under seal of the University, at the Capitol in Albany, March 19, 1896.

(Signed) Anson Judd Upson, Chancellor.
(Signed) Melvil Dewey, Secretary.

1896 — ELEVENTH YEAR — 1907

CHARTER DAY EXERCISES.

1896 — Eleventh Year. — 1907.

The eleventh anniversary of the granting of the Charter of the Thomas S. Clarkson Memorial School of Technology, by the University of the State of New York, was observed Monday evening, March 18, 1907, by appropriate exercises in the Chapel Hall.

The religious portion of the exercises was conducted by the Rev. F. L. Masseck, of the Universalist Church, Potsdam, N. Y.

The musical part of the program was renderel by the Clarkson Tech. Orchestra, the Welker Brothers, '09, Managers.

Mr. Rea M. Gordon, B.S., '02, Assistant Engineer of Tests, of the Solvay Process Co., Syracuse, N. Y., communicated a response on behalf of the Clarkson Tech. Alumni Association, which was read by the Director in the absence of Mr. Gordon.

The Director made the announcement of the Levinus Clarkson Scholarship being provided for and open for the succeeding college year, 1907-1908. This Scholarship of $100, was established on the Decennial Charter Day, March 19, 1906, and the announcement of the annual award is made on Founder's Day.

Program.

March—"Arabia,"... ... ...Buck

Orchestra.

Scripture Reading.

Selection,... ... ...Carle

Orchestra.

Invocation.

La Mattchiche—"Sorella,"... ... ...Berac

Orchestra.

Address:

"Capacity for Service: an Ideal in Technical Education,"

Frederick Remsen Hutton, E.M., Ph.D., Sc.D.,
Professor Mechanical Engineering, Columbia University,
President American Society of Mechanical Engineers,
New York City.

Waltzes—"Red Mill,"... ... ...Herbert

Orchestra.

Alumni Response:

Rea Milton Gordon, '02,
Syracuse, N. Y.

March—"George Washington, Jr."... ... ...Cohan

Orchestra.

Benediction.

CAPACITY FOR SERVICE AN IDEAL IN TECHNICAL EDUCATION.*

By Frederick Remsen Hutton, E. M., Ph.D., Sc.D.†

I. Introduction.

In selecting a topic for an address on Charter Day, of 1907, before the trustees, faculty, students and friends of the Thomas S. Clarkson Memorial School of Technology, the thought of the speaker has been directed to the thesis which underlies the foregoing title. His contention is to be that such education as is to be acquired here and in other institutions of kindred aim is an admirable preparation for usefulness and opportunity in a modern community.

It should not be necessary in this presence to establish and defend the economic platitude that the community as a whole is uplifted by the work of every man who makes two blades of grass grow where only one grew before. Exactly parallel to this is the idea that the community is uplifted by such increase of wealth as gives to raw material or to products of the soil an increased value by expending labor thereon, so that that which was heretofore worth a dollar has now a value of two dollars by reason of its increased utility or availability for the common need. The raw material has its value, to be sure, when buried in quarry or in mine; the untilled land has its valuable potencies for service and the free flowing water of the river is an asset as well as a delight to the eye. It is only, however, after human labor and brains and service have been expended on them that they become wealth-producing factors of the community life. It will be plain that this process of economic production from farm, mine, factory power plant and railway must underlie the further development of the community in art, in culture, in refinement, to some degree in education, and in conditions favorable to good citizenship. This must be, because when the economic struggle is severe and the margin is narrow between wages and salaries and what they must buy on the one hand, and the cost of production of these articles on the other, the average citizen has no time nor energy to spend upon personal betterments. He must keep the wolf not only from the door but outside the door-yard. If the yard is small the wolf is by so much nearer to the door. Sickness, death, non-productiveness of any kind, while demands continue must have such demands met from the accumulations in this narrow margin. On the other hand, as educated engineers and production-experts improve and cheapen the processes and costs of production, the cost of purchase should diminish and the purchasing area of the producer's wages should go up. With this larger margin and deeper door-yard area it becomes possible to take thought for matters outside of the bare necessities. The son and the daughter can be kept longer at school; it becomes possible to buy and read books because there is time and light after hours of labor to do so; modest art decoration appears in the home; a civic pride in beauty of the streets arises; attractive churches, libraries, museums, picture galleries, municipal monuments, parks — everything which differentiates a full life from mere living become the possibilities of more and more

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*Charter Day Address at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., March 18, 1907.

†Professor Mechanical Engineering, Columbia University, 1877-1907. President American Society of Mechanical Engineers, 1906-1907, and Secretary from 1883-1906.

people. I claim that the seed from which all these grow, is the widespread following of the fundamental principle that the community is enriched in proportion to the numbers who contribute useful service in the processes of industrial production.

It would take me too far afield to refer at any length to another side of this subject having reference to the impoverishment of the community by certain service, which at present seems inevitable. There must be some charges for brokerage and agency to meet the necessary expenditure in distribution and handling of product. An unnecessary broker or a superfluous merchant, and worst of all, a self-seeking manipulator of stocks are consumers of wealth and not its producers. Most of the time they are working for themselves alone when engaged in their bread-winning processes and are not serving the community also. Their labors and assiduities impoverish but do not enrich. There is no question that in the minds of many, who have not had occasion to think very far into the matter, much jealousy of accumulated wealth and much socialistic trend of opinion have resulted from the sight of a selfish manipulation by financial magnates of the very means of economic production by which the community at large is rendering its service. People see large wealth suddenly appearing in individual hands out of the very machinery of plant and buildings where they toil for modest wages. If the wealth made apparent, was really there, a larger share of it should have found its way to us, who have made real production possible and effective. When, furthermore, by purely capitalistic methods a lowered cost of production is enforced at the expense of the proportion of receipts available for wage-earners, they naturally resent that their economic ship should be more deeply immersed by the water ballast, which has been pumped into her, whose only effect, so far as they are concerned, is to increase the engine effort required to keep up the old rate of speed.

There should be no question of the economic advantage to the community of the large-scale undertaking as contrasted with the small one. Its normal working should be gradually to lower the cost of production, and, therefore, to increase the wages paid to employees. It should diminish wasteful duplication; it should save money by avoiding extravagant competitive advertising; it should secure permanence and continuity of his labor for the wage earner. It has too much at stake to stop production for a whim or an alarm; but this it can only do if its production processes are normal because undisturbed, and its dividend rate not liable to sudden and jarring fluctuations, caused by a desire to make stock values fluctuate. When there are no fluctuations there is no fun in manipulating the stocks. The financing manipulator and the real producer are at opposite ends of the commercial game with interests always at variance. The interests of the many are those of the producer. The manipulator enriches himself without advantage to them or the community as a whole.

My purpose, however, is wider and more general than the obvious relations of the producer to the material happiness of the community. The technically educated production engineer is very plain and visibly rendering this sort of service. It seems to me that in developing the thesis of the service ideal there should be established the two following points:

1. That the service ideal is a defensible one in philosophy as an ideal for a life.

2. That technical education favors or can favor this ideal.

Then will follow two questions:

1. What kind of technical education favors this ideal the most?

2. How can you personally realize such an ideal?

XI. Service as an Ideal.

It was recorded by the Greek thinkers of an early day that the instinctive reaching out of the race is after happiness. Being necessarily materialists, these philosophers could see no other ideal than earthly happiness. Their gods were the creations of their own poetic and gifted imaginations, but at best were only deified men with higher powers and possibilities, but the same motives and passions. To secure health and pleasure and freedom from pain for the body, and to attain contentment or buoyancy of spirit was ideal enough. During youth, while bodily or sensuous pleasure was enough to bring happiness or forgetfulness, then the Epicurean ideal was uppermost. Let us eat and drink and so forget the sorrow and pain which is about us by keeping our mind off of them. Wealth secures happiness of this kind: let us achieve wealth. Or again, in later life and in more ascetic guise appropriate to a stronger mentality and diminishing physical capacity, the Stoic solution was approved, where the spirit should rise superior to the buffets of the ills of life, and the man in a calm serenity and with unruffled mental poise should endure pain and grief without flinching or succumbing to their potency. Or again, there has arisen the East Asian ideal of so concentrating the mental activity on non-mundane affairs that these latter shall gradually become intangible or illusory. There is no real pain or worldly evil, but it is all "maya" a delusion, and the life ideal is an attainment of a Nirvana with extinction of desire for life and present realities.

These are all individualistic systems. Their basic idea is that the individual shall secure his own happiness-ideal for himself — perhaps even at the expense of those about him. This last is notably the case with the East Indian or Buddhist concept where he who is in pursuit of lasting happiness must give up such worldly avocations as would support him in economic independence. On the contrary such devotee is to be supported by the community in which he lives by gifts to his mendicancy. Here is a fatal lack of agreement between the western economic concept and that of some of the Asian countries. All the old or merely human philosophies lack the sense of communal or social welfare as a factor in happiness, or the idea that such welfare is something to be worked for as a means to attain happiness.

Something less than 1900 years ago a new philosophy and a new set of ideals were originated at the east end of the Mediterranean sea. In opposition to the Epicurean and Stoic ideals of selfish advantage, it stated that a better ideal was to be found in seeking the good and welfare of other men. The selfish individualism of the existing philosophies tended to narrow men and make them self-centered until finally they shriveled. The altruism of the Christian broadens his interest and at the same time deepens the channels of his interest. The old philosophies left him, who had succeeded in attaining his ideals, still unsatisfied and searching after something else. The new philosophy brings happiness and content with its every exercise. The noble soul expands under it and in so doing gathers new capacities for happiness. The success of this philosophy has been one of its marvels. From small beginnings it has spread from nation to nation — its very basal idea being the happiness of those who bear burdens to extend its sphere to others — until it is plainly destined to be the philosophy of the future and of the whole world. It so fits the best or divine part of each one of us as to form a strong and cogent argument for its divine origin. Its essential maxim is: "The life which attains happiness is the life spent in service." Its great exemplar and founder showed us a happy life in spite of homelessness, privation, incessant labor, calumny, misunderstandings and, hardest of all, desertion. The greatest

expounder of its philosophy — one Paul, born in Tarsus — shows us a life of exultant fulness in spite of perils of rivers, perils of robbers, perils in the wilderness, perils in the sea, perils among false brethren, hunger and thirst, cold and nakedness, prisons, stripes, even in deaths oft. We have only to look back over the centuries to decide that he is greatest among us who renders the most service.

But not alone does the faithful and conscientious laborer in production enrich and gladden the community in a material way and not alone does he put himself in line with the highest philosophy on the intellectual plane. By his conscientious self-sacrifice of himself for duty's sake, and by unselffish foregoing of merely personal ease, he becomes in moral character and principle an ornament to that community by reason of what he is in himself. By his faithful and effective doing of his allotted task there comes to him that highest form of satisfaction to an earnest man, which flows to him from the consciousness of work well done. The old Hebrew poet recognized this element in us when his gifted vision saw the glad delight of the all-conquering sun coming up over the horizon path and rejoicing to run his race with the delight of the strong man in achievement. Rudyard Kipling with his marveolus literary insight into technical matters confides in us his impression of the powerful locomotive at its work. He tells us what he felt when locomotive No. 007 with the massive midnight train of sleeping coaches behind him comes roaring along the gleaming steel, tossing miles over his shoulder as a carpenter's plane throws the shavings behind it, and "singing his happy giant song," as he rushes away into the night. These images of successful achievement appeal to us whether our blood yet swirls in our veins with the fire of youth or pulsates with the more sedate and placid flow of later life. We enjoy saying to ourselves "Well done, faithful servant," day by day, and at nightfall to derive the satisfaction this brings with it here and now.

Finally, under this head, when the rendering of effective service has won its compensation and makes possible a further service in the form of visible beneficence to the community, to whom does this latter give the greatest satisfaction? When a donor enriches his community with the gift of a library or an art gallery or a museum or an educational undertaking, does the social fabric as a whole get even a small fraction of the pleasures and satisfaction from it, which come to its creator and originator? Who think you, gets the most pleasure from the Clarkson Memorial School whose Charter Day we are celebrating at this time? I do not believe the student-body does, for amid all your good times, your life work and its highest satisfactions are yet in the future. While you have the pleasures of hope, health and friendship to beckon you, you have not yet found yourselves and tasted as yet the form of satistaction which your best work will bring. I do not believe the teaching staff does, for while they have found themselves and are finding that highest satisfaction, which comes in work done for others, they are winning their own way in the process. Higher than both of these is the pleasure and satisfaction of those who have made both of these contentments possible, and are doing this without receiving a material return. They are multiplying their own capacities for usefulness and service many fold by creating the opportunity for service to the one class and inspiring all the labor and the task of preparation for the others. All honor to those whose clear vision and enlightened judgment have made Charter Day for Clarkson a realized fact.

III. Does Technical Education Favor the Attainment of the Service Ideal?

As our path enters this section of our subject, we find it trodden and dusty with the foot-prints of the controversalist about education in general, and the respective claims of the classic-literary school on the one side and the scientific-technical school on the other. I think that polemics can be avoided if we can keep to certain broad principles for the purpose in hand, on which most can agree. I shall make no attempt to conceal my own obvious sympathies.

There are two points of view possible. The one regards the educational center as a place to which the student comes to receive a discipline of mind by study and perhaps also a discipline of body by reasonable athletics. It is the purpose of this discipline to make a better man of him and to equip him mentally with a useful kit of tools in that department and give him some knowledge and skill in their use. The nature of the gymnasium apparatus used in this training process, which is the list of subjects which he shall study, is held to be of secondary consequence provided only it is perfect of its kind. That which has been proved to be perfect of its kind by the experience of the fathers and by the conditions of an aristocratic country, has a distinct presumption in its favor. At the other extreme is the view which regards the school as a fountain or well-spring of information and of facts to be imparted by skilled and expert teachers. These are to fit the graduate to deal intelligently with the problems of actual life, since he has come to know the laws which govern practical affairs and has absorbed some of the garnered experience of the skilled professors who have worked with him. Life will furnish the discipline fast enough after graduation, but gives little opportunity to learn the laws except by hard knocks. Let us, therefore, concentrate our effort on acquiring the knowledge. This is the philosophy underlying the successful effort of the correspondence school method.

Now let us apply the test of our touchstone in the foregoing discussion to these two philosophies. It seems to me that there need be no contradiction in these two requirements provided that each is rightly interpreted. The difficulty is to attain both ideals in a limited period. The safe middle course is so to use the study and the acquiring of physical fact and of experimental data upon matter, force and their laws, as to make such study a discipline for the mind and heart. This is the trick and the skill of the competent and successful teacher. Either extreme has its own dangers. If the student spends his four years in study of antiquities or of abstract science unrelated to the ordinary activities of life, and has pursued literature and history as culture subjects unrelated in their bearing to present day thought, he may become polished and outwardly cultured. But the first man who tries to lick him into usable shape in active business usually finds him less available as the result of equal labor than the office boy or the apprentice, who has begun at another round of the economic ladder. The graduate also from this system of education has usually been favored with the modern system of practically free election of subjects of study in his college. This possibility of doing what he likes and which appeals to him, gives the young man a mistaken conception of the way things are done in the life of actual affairs; and the change from one environment to the other is so sudden and abrupt that he resents it and is unhappy or useless under it. Actual life forces him to a process, which seems to him like unlearning something which he has worked to get. Both employer and employed in their discontent form an opinion unfavorable to *all* sorts of higher education because the one sort under comment proved to be ill-chosen for the purpose in hand.

The great danger of the other system at the other extreme is that it should fall short of its disciplinary value because the student fails to see clearly what is his own function in the education process. It is possible that both teacher and student permit the latter to become a mere mass of absorptive tissue, taking in information and knowledge as does the dead sponge rather than by a process similar to that which is exhibited by the living tree. The lecture system of instruction by gifted experts is particularly open to this danger, since the student can be so easily lulled into a Nirvana of admiring idleness of mind, or into a state in which presence of body concurs with a practical absence of mind in the class-room. Of what use is an extensive assortment of note-books containing data, such as are gathered in our best engineers' pocket-books, if the young man has not been trained to use his faculties or exercise his powers upon them. Worse than this, is the possibility of making wrong use of valuable data and truths because still uneducated in spite of his knowledge. No more useless product of an alleged educational process is turned loose on the industrial community than a so-called educated man, whose capacity is limited to a bookful of assorted recipes for producing certain results. He may be likened to an engineering cook-book. His results taken internally by productive works gives both masters and plant a figurative dyspepsia. He is underdone, but alas, not rare.

But when the thing is done right and the man is forced to think correctly, persistently, and to a definite and positive result, then the training in knowledge of physical law, in observation of phenomena, in constructive combination of apparatus for their study and in deduction from experiment, is, in my opinion, the most valuable there can be. There is no quality or attribute so valuable in any environment as that which we call initiative. This has been cleverly defined as the ability to do the right thing at the right time without being told. The classic or purely literary training does not foster this power of initiative. On the contrary, the perfectness of the classic models and the inevitableness of the study of the past tends to discourage and dissipate this power, unless the young man finds an outlet and a discipline for it in athletics, in the management of college journalism, and the control of musical or dramatic interest. The training in the mechanical laboratory of the technical school, on the other hand, can be directly and of purpose aimed to foster and stimulate this power. What the world calls for in its useful men is the capacity for resource to cope with conditions, which have not arisen hitherto and to meet new obstacles and overcome them. Nature rarely gives to the same man a retentive memory for things which are past, and the faculty of initiative and resource for problems of the future. The retentive memory enables a man to show well in his college class-room. He is perhaps the honor man or valedictorian under the old conditions. The other power is the one which makes him the class president, the football manager and which tells later in the world of affairs. Hence, if my contentions are sound, and it be granted that usefulness in life is an ideal, then the education in applied science is that which can be so used as to fit a man best for practical usefulness in an industrial community which is built upon and is dependent upon the utilization of nature's laws.

IV. What Kind of Technical Training is Best Fitted to Attain this Service Ideal?

In all that has preceded, the service before our minds has been that which is needed in an industrial community engaged in production. The latter I have defined as the process of increasing wealth resulting from spending labor upon a raw material or a product of the soil. I think an

older ideal that education should be so directed as to fit every boy to rise to be President of the United States is one which has worked harm upon our practical thinking. It is manifestly impossible within seventy years of a man's natural life that more than a very small number of the many millions of our population should ever reach this eminence. What of the many debarred from this possibility, but who must yet be wage earners.

In the forwarding of modern economic production it seems to me there is a demand for three kinds of ability. The education in the community should be directed to discipline and knowledge in each field of service. This recognizes the generally received analysis that under the board of directors of a manufacturing corporation will be the three departments, which may be designated as the works or productive department, the office or accounting department, and the sales department. In developing this analysis it will be plain that the largest group numerically will always be the artisan or craftsman class, who work with their hands upon the raw material either directly or through the media of tools. These tools they do not or have not designed but they operate them and make them go. These are the workers at their respective trades; they enter them as bread-winners or producers after their childhood's contact with the public school, and either after their contact with such schools has become completed or before. For this great group it seems to me that the call is the loudest that proper provision be made that they should be specifically fitted for usefulness by the education which they receive before going to work, or which they may receive during its continuance. Their numerical importance makes industrial education for such persons a splendid opportunity for those who are gifted with vision and with wealth to render their service in this form. This education need not be deep nor decorative, but it should be broad and practical. It should be so directed that it may be an inspiration for the daily toil required of those who must be wage earners as a means of personal or family support, and who must be economically productive from boyhood. It should cover the scientific and natural laws behind the material things which they handle or control. It should reveal the intellectual and philosophic basis of their life, making it not unworthy of the divine element in man. It must make him more than a mere high-class, automatic machine. It must show the man that he is greater than his work and that this latter is a means and not an end. It must show him that possibilities of growth and achievement are his personal right, even while he appears to be contributing only as a unit in the productive process. All honor to wealth and to achievement, which have seen and shall see this opportunity of service to the craftsman and shall move forward to meet the demands for industrial education among the wage earners.

A second class will be the organizers and directors of the craftsman, who, together with their machinery and plant, form the producing apparatus which we call a factory or mill or works. In this group will be the general managers, the draftsmen, the engineers, the superintendents and the industrial organizers. To this class belong the product turned out by the engineering schools. The young engineer in either the mechanical or electrical specialization of the day is likely to be a manufacturing engineer. They must necessarily constitute a smaller class than the preceding, but from their duties and function they will be the best paid. They are the most vitally essential under modern competitive conditions, where conformity to physical law is imperatively demanded if success is to be won without its costing too much. For these men knowledge of the crafts which they are to control is essential, but even more so a knowledge of science and its laws, covering familiarity with accepted solutions for old problems and the trend of research into new ones. For

such men beside the class-room, the laboratory, the drawing-room and the school-shop, will form the desired equipment. All honor to Clarkson and to other institutions of like grade and character who are seeking to satisfy this call. The usefulness of such institutions is deep and is far reaching because profound. It is not so broad nor so far reaching in the other sense because the numbers affected are less.

The third type of service is rendered in the office and in the commercial functions of the producing process. Such service is rather what is technically designed as "personal" service rendered to the producer class rather than a direct contribution to community wealth. The compensation of such persons is a draft upon the producing cost, and hence they ought not to be too numerous. They help the easy conduct of the production process and will be fitted for their work both by special commercial training such as is offered in business colleges and correspondence schools, and by such general education as shall give them broad views, a wide range of adaptability and a capacity for suggestive recommendation in their appropriate field. The tendency, however, of modern intensive production is to reduce this class to its lowest terms.

I put, therefore, the education of the craftsman group as the first or prime need of a service education because affecting the greatest number of the producing class. I put the education of the selected group of designers, works managers and directors of production as second only to this opportunity by reason of the less numbers affected and not by reason of any misapprehension of the importance of having the duty of these men well done.

V. How May You Personally Attain this Ideal of Service?

The final stage of my argument must seek to make the theory of the foregoing apply as a personal matter to each one of us in his practical affairs if it is sound. For there is no such thing as rendering a real service if it is of no use to anyone. How can we be made useful by reason of our training; or how can technical education make us useful?

I shall be satisfied if I can fasten two practical answers. We will, of course, be made useful and render service almost in our own despite if we engage in economic production and apply our talents and knowledge and skill to this end. But higher than this and as a means of making the best of ourselves I would specially urge that each should so labor that every study and every problem and every law is made a compulsion that we should think.

I have condemned already the mechanical-recipe system of working out solutions by rule and without much thought. This may be used to make a well-informed man but it will not make an educated one. The two terms "educated" and "well-informed" are not synonymous. I demand that the process of education should be so directed and planned that the powers of the student's own mind shall be awakened, stimulated and compelled to exert themselves. The mechanical laboratory is particularly well adapted to secure this result, because from the practical and material apparatus before the student's eye and under his hand, he can be forced to consider the connection between his mental concepts and the actual occurrence before his senses. He should be compelled first to think clearly and definitely and to enunciate what the experiment is aimed to show. He should then create or assemble apparatus suitable and necessary to answer his inquiry or to prove his assertion. He should then so arrange the apparatus as to make it truthful and accurate in its reports and give his reasons why or to what extent it is thus reliable. He should then record and finally discuss his observations upon the forces and laws at work before him. While it is a manifest labor-saving process

to furnish the laboratory student with printed log blanks, having headings previously worked out over the columns which are to be filled with his observations, I consider that such labor is saved at an educational expense of a greater equivalent. The man may complete more experiments by the log-blank method; but by the other system the experiments, which he had made under it, are parts of his mental, as well as his bodily experience. They have, furthermore, compelled a mental activity which is a calisthenic exercise in itself, and which leaves him a different man and a better one than he was before. I have condemned already the danger of smooth and facile lectures taken by a free election and without reference to the student's own needs. Education should teach a man the meaning of a task as a thing to be done whether he likes it or not, and should also teach him to use his mind upon his task.

The other thing which I would urge is that the subject-matter or content of the experimental study to be used as discipline be chosen from among the play of laws and forces, which concern the common and usual experiences of an industrial life. The purpose of this recommendation is to minimize the difference in atmosphere and condition at the educational center from that which is sure to prevail in actual life. There must be a difference, since the unit or standard of measurement in real life is the dollar, while that most suitable for the educational institution should be one which is not a variable with expediency as its exponent. In working under nature's laws in practical affairs it is as true for us as for the old writer that all things in accordance with such laws are lawful for us, but all things are not expedient. At the school the learner must have it brought home to him and clinched that nature cannot be lied to nor deceived. She insists upon truth in the inward parts and must be obeyed no matter what it costs. The training in what is practically or economically possible under nature's laws and what is, therefore, expedient must be the function of life itself after leaving the school, and the best of us can only hint at such matters in the educational process. Within the limitations, however, which are set by the conditions, let the learner get in as close touch as possible with the facts and phenomena of the world of practical affairs. The technically educated man has this great advantage over his academically trained associate — that for the latter the classic languages, the civilization of dead nations and their history, the refinements of psychology and even some forms of literature and antiquarian research are without immediate relation to the functions which the man is to discharge when he becomes a worker. Never have I seen this more tersely put than in the epigram of Prof. John E. Sweet of Syracuse, when he compared the usefulness of him who knew "what to do and how to do it" with that of another "who only knew what had been done and who did it."

VI. Conclusions.

Hence may I ask you to agree with me and carry away with you your concurrence in the contentions which have been advanced.

First. That a life of service and usefulness is a happy and successful one.

Second. That to found an institution, such as this, whose Charter Day anniversary we are celebrating, is to render a service to the community of the greatest magnitude and importance.

Third. The education of the young man and the young woman to be economically productive is to favor the growth of economic wealth in the community, with its attendant and secondary consequences of culture, contentment and higher standards of living.

Fourth. That there is need in the community for such provision of education as shall fit the numerically superior class of wage earners to make the best of themselves and increase the value of the service which they render.

Fifth. That such education as shall be disciplinary to the mind as well as informing, is that which will best realize these ideals.

Sixth. That the responsibility for getting the most from the opportunities presented at any school, lies of necessity in the last reduction with the individual student himself.

With these last words may I join with you in the wish that to the Thomas S. Clarkson Memorial School of Technology may come many years of increasing usefulness in its grand work of fitting men for the best ideals of service.

THE CLARKSON TECH. AT THE OPENING OF THE SECOND DECADE.*

By Rea M. Gordon, B.S., '02.**

Eleven years ago, "The Clarkson Tech." came into existence, founded in honor of the memory of Thomas S. Clarkson. Since the first Charter Day, seven classes have graduated and one is now looking forward to Commencement, or rather the beginning of their life work.

Fellow engineers, we have chosen an honorable profession, not one of ease, but of strenuous endeavor, indeed that of "A workman that needeth not to be ashamed". We are living in a progressive age. Capitalists are coming to the engineer to find ways of investing their money with profit to themselves and of benefit to mankind. It is an age of specialists, but a broad, thorough training is necessary to the specialist. This is received at Clarkson Tech., and most thorough it is, as we can readily testify.

The engineer must be loyal to the interests that employ him. The old saying goes, " An ounce of loyalty is worth a pound of cleverness," yet they must be found combined in the proper proportion. He must be honest in the highest sense of the word. The man who doctors reports of tests to make a creditable showing or who advises the investment of capital merely for his own personal gain is as dishonest as the man who steals from the cash drawer. The physician may bury his mistakes but those of the engineer live after him.

The engineer must exercise vigilance in the performance of all his duties. His employer regards him as part of the assets of the concern, and he must earn the market rate of interest on the invested capital, else he loses his standing and position. Wastes must be reduced to a minimum, output increased to a maximum, with the lowest possible expense consistent with good product. He must earn more than his salary, and the more he earns for the company the faster will he be

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*Response in behalf of the Alumni, Eleventh Charter Day Exercises, March 18, 1907.

**B.S. in Mechanical Engineering, 1902, Assistant Engineer of Tests, Solvay Process Co., Syracuse, N. Y.

advanced. In being loyal to his employer's interests he will thus be ever loyal to himself.

We are living in a time when men and machinery are worked to their maximum capacity, and a great many times at an overload. The pace certainly is rapid. It has often been said, "It is the pace that kills". Is it not rather the difference between our velocity and that of the world about us? In order to keep up with the speed or rate of progress of the world, we must cast aside the hindrances which beset us, such as worry and discontent with our surroundings. If we put ourselves into the breach with a clear head, and strong body, doing well the duty or task assigned to us, we can keep up; and it is not the pace that kills. We cannot choose our particular part of the work, that is the function of another; but we can do well the part assigned us.

The Clarkson Tech. man is certainly well fitted for life. The systematic training, the thorough courses given, united with the loyalty and patience of her Faculty, produce results which I believe have been proven by those who have selected Clarkson Tech, as their Alma Mater. It has never been my misfortune to have regretted the years spent in these halls. Indeed, I am proud to be known as a Clarkson Tech. man.

We have just passed the first decade which has marked an epoch in the history of our Institution. Shall we not work still harder to make the second decade greater than the first, and each succeeding one still greater? With our new Gymnasium assured, let us not cease till we shall have a Twentieth-Century Tech., and shall have accomplished the cherished desires we now hold; and then consider that we have just begun.

Some one has said, "We cannot all be passengers in this voyage of life, some must go before the mast." Whether we are before the mast, or permitted to guide those who are standing at the mast, let us work and keep up to the tune of the Decennial prize song, The Clarkson Spirit. In other words, "Happiness is the by-product of Industry". Working for work's sake, the satisfaction of duties honorably and well performed, is in itself success and happiness. Material success is sure to follow.

Let us press onward and upward, working with high ideal, the Clarkson Ideal, till the name of the Thomas S. Clarkson Memorial School of Technology is known the world over, that it may perpetuate, in honor, the noble work of our Founders in thus memorializing the life and work of their brother, Thomas Streatfeild Clarkson.

THE THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.

This Institution was founded in 1895. It was chartered March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year. The object of the Clarkson Foundation is to provide technological education of college grade. For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language and literature, the applied and economic sciences, engineering and technology. They lead to the

degree of Bachelor of Science in the major course pursued; namely, chemical, civil, electrical and mechanical engineering. The degree is conferred by the Regents of the University of the State of New York upon the recommendation of the Faculty to the Board of Trustees of this Institution.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

Building.

The main building of the school is 87x57 feet, and has two wings, each 180x36 feet. All is built of carefully selected Potsdam red sandstone, finished inside in quartered oak and hard pine, with hard-wood floors. It is substantially of fire-proof construction, ventilated by fans, heated by both direct and indirect steam radiators and lighted by electricity. In the main building are the Director's office, library, recitation rooms, chemical and physical lecture rooms, and laboratories, drafting rooms, and the assembly hall with a seating capacity of 500. In the basement are the boiler rooms, photometer, photographic dark rooms, and toilet rooms and lockers. The east wing is occupied by the wood-working shop, the machine-shop and the steam engine and dynamo rooms. In the west wing are the chemical laboratory, the electrical and mechanical engineering laboratories and the forge shop.

Library.

The library of the school contains a classified and indexed collection of standard and latest books in the lines of the school's work; the transactions of scientific and engineering societies; and selected American and foreign technical journals and periodicals.

Chemical Laboratory.

The chemical laboratory is provided with tables, fitted with porcelain sinks, plate glass shelves for reagent bottles, and every convenience for handling experimental apparatus and work. The hoods for use in the generation and manipulation of noxious gases are exhausted by power fan. The facilities for advanced experimental and research work are excellent. The equipment includes several sets of extremely delicate analytical balances, assay balances, power crushers, ore grinders, furnaces and other accessories for gold and silver assaying, an electric furnace for metallurgical work, a New York State legal oil tester, a Doolittle torsion viscosimeter together with the hydrometers, Westphal balances, etc., for the examination of fuel and lubricating oils; the standard forms of apparatus for gas analysis, and a Mahler bomb calorimeter for the exact determination of the heat value of coal, oil and other kinds of fuel.

Owing to an increasing appreciation of the importance of a knowledge of the microscopic structure of the materials of construction, the school now offers facilities for work of this nature. The apparatus for this work includes two microscopes with vertical illuminators and camera holder, one six-spindle polishing machine, one electric projection lantern with condensing lenses for illumination of specimen, together with a well-equipped dark room for the photographic work.

Laboratory of Physics.

The laboratory of physics is devoted to instruction in general physical measurements. Special rooms are provided for light and electrical measurements and dark rooms for photometry and photography. The laboratory is provided with apparatus for general physical measurements in mechanics, light and heat, and is well equipped with instruments for electrical measurement, including tangent, D'Arsonval, ballistic and Kelvin galvanometers, improved form of Carey-Foster bridge, meter bridges, condensers, Wheatstone bridges of simple and of the Anthony form, resistance boxes, special megohm resistances, and apparatus for the measurement of induction and the magnetic qualities of iron. The photometer room contains a Reichsanstalt photometer of the latest design, having a three-meter scale and provided with accessories for the measurement of artificial light, including gas, arc and incandescent lights.

Electrical Engineering Laboratory.

The electrical engineering laboratory includes in its equipment two 25-kilowatt 110-volt direct-current compound dynamos, two 7½ kilowatt rotary converters, arranged for operating as a single, two or three-phase machines, a 5-kilowatt low-tension three-phase alternator, two 10 horse-power and one 5 horse-power shunt motors, transformers of different types and sizes and several small generators and motors, including examples of the polyphase induction type.

Two one-kilowatt machines designed as rotary converters are arranged to illustrate methods of testing direct and polyphase-current machines.

The laboratory is provided with apparatus for determination of wave forms, is well equipped with wattmeters, direct and alternating-current ammeters and voltmeters, and contains suitable standardizing apparatus.

Mechanical Engineering Laboratory.

The power plant of the school consists of two 80 horse-power horizontal tubular boilers; two 40 horse-power vertical high speed engines direct-connected to multipolar dynamos; one 80 horse-power Wheeler surface condenser; one 15 horse-power Otto gas-engine; a duplex steam pump and 10 horse-power steam-engine, the whole being specially arranged for experimental work, constitutes an important part of this laboratory equipment.

The laboratory is also supplied with an Olsen testing machine of 100,000 lbs. capacity, for tension and compression tests of specimens six feet long, with an attachment for making transverse tests of beams and trusses up to sixteen feet in length; an Olsen torsion machine of 200,000 inch-lbs. capacity, for torsion tests of shafting up to 2½ inches in diameter and sixteen feet in length; and a Fairbanks machine of special design for testing the strength of cements. Additional apparatus, consists of calorimeter for determining the heating value of coal and other fuels; steam-engine indicators, planimeters, scales, gages, thermometers, extensometers and other measuring instruments; injectors, steam flow apparatus; pressure tank and weir box for hydraulic experiments. A Venturi meter and other water meters are also part of the laboratory equipment, likewise, apparatus such as prony brakes, absorption and transmission dynamometers; indicator spring testers; belt testers; and other devices designed and made at the School.

Workshop Equipment.

The wood-working shop contains twenty-four benches, twenty 10-inch lathes, one 16-inch lathe with 10-foot bed and overhanging face-plate, capable of turning work up to 80 inches in diameter, 24-inche surfacing planer, 18-inch buzz planer, a universal rip and crosscut saw and a band saw.

The machine shop has ten screw-cutting engine lathes, two speed-lathes, a 20-inch upright drill, a sensitive or friction drill, a Whitcomb 20-inch planer with 6-foot bed, a Landis universal grinder, a Cincinnati universal milling machine, a Gould and Eberhardt shaper, a power hack-saw, a grindstone, a water emery grinder, small bench grinder, a Worcester universal drill grinder, an arbor press, a gas tempering furnace, a small crucible furnace for tempering in molten baths, and twenty-four vise benches arranged for instruction in vise work. The tool-room adjoining contains a well selected variety of machinists' small tools and appliances. These are loaned to the students upon the check system.

The forge shop has twenty-four forges and anvils, and necessary small tools, shears, blacksmiths' drill, bolt-header, vises, swage-block, etc. A few forges are equipped with hand-blowers in addition to motor-driven power blast.

The foundry equipment at the school consists of a brass furnace, a gas-melting furnace, a core oven and the usual small tools and flasks for moulding.

EDUCATION FOR ENGINEERING PROFESSIONS AT THE CLARKSON SCHOOL.

The four year courses in engineering afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical and mechanical engineering. The instruction taken in common during the first two years provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of engineering science, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting tests and researches.

The technical instruction of the last two years, in the theory and practice of engineering, affords the student substantial preparation for immediate usefulness in engineering workshop or laboratory, office or field, by intelligent application of principles to the successful mastery of his field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their chosen profession.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large.

Chemical Engineering.

The instruction in this course is designed to be such as will give the student a thorough grounding in the fundamental principles of engineering, together with such training in chemistry, general, analytical and industrial, as will enable him to be of service in the design.

construction, and operation of chemical plants and the development of processes involving a knowledge of chemistry. During the last two years of the course considerable opportunity is given the individual student to select work along those particular lines which he intends to follow after graduation.

Civil Engineering.

The above course, as distinct from the courses in chemical, electrical and mechanical engineering, includes railway, structural, municipal, mining and geodetic engineering. As an example of the lines of work taken up the following special features may be noted: In railway engineering, a railroad line is located, cross-sectioned, and staked out in detail, with complete maps and profiles, computations of earthwork and costs. Structural engineering includes courses in bridges and roofs, structural design, masonry and foundations.

In structural design each student designs a steel railway truss-bridge, being assigned a length, height of truss, and loading, by the instructor. He calculates the stress in the diagonals, verticals, upper and lower chords, stringers and floor beams, making regular reports to the instructor. Each student also designs the members of the truss for which he has computed the stresses and makes drawings of the various members, separate and assembled. In the course on the design of a concrete arch, each student designs a reinforced concrete arch of a given span, rise and loading. In both of these courses the length, height, and loading, of the bridge or the arch assigned for design to one student are entirely different from those assigned to any other.

Municipal engineering comprises water analysis, hydraulics, water works, sewerage construction, sanitary science, roads, street pavements and city surveying. Mining engineering embraces geology, mineralogy, mining methods and surveys, and assaying. Inspection trips are made to the iron and talc mines near Gouverneur, N. Y. Geodetic engineering includes especially geodesy and astronomy, and hydrographic surveying, fitting graduates to take positions in the United States Coast and Geodetic Surveys.

Electrical Engineering.

This course is designed to fit young men to engage intelligently in the production and operation of electrical apparatus and in the application of electricty to the arts and sciences. It provides, besides foundation work, such as physics, chemistry, mathematics, mechanics, and drawing, specialized studies in electricity and applied electricity. These involve the theory of electricity and magnetism, and their application to direct-current machinery and electrical measuring instruments; the theory of alternating currents and alternating- current machinery, comprising alternators, synchronous and induction motors, rotary converters and rectifiers. Elective courses are also given in electrical distribution, electric lighting, and the art of illumination. These include the solution of problems naturally arising in the commercial generation, transmission, distribution and utilization of electric energy. Work in the electrical engineering laboratories is co-ordinated, as far as possible, with the lectures and recitations, and aims to give a study of the methods of electrical measurements, practical knowledge of the testing and handling of electrical machinery and accurate instrumental measurements.

Mechanical Engineering.

This course considers the development of power and its transmission and utilization by machinery. It treats of the principles of machine design, with applications of the same; power development by steam and gas engines and hydraulic motors; experimental study of strength and characteristics of various constructive materials; methods and practice of economic workshop production and mechanical construction; tests of motive-power machinery and power plants; calibration and standardization of instruments and apparatus used in measuring power; and other work appertaining to the profession of mechanical engineering.

EXPENSES.

Tuition.

Annual tuition, for each of the four year courses, $100.

The tuition is payable in semi-annual installments, at the beginning of each semester and by all matriculated students.

An admission fee, of $5.00, will be charged all students on and after September 11, 1906, upon their admission to the School as regular students, or as special students in any course of at least ten semester hours.

Students who enter upon any course or semester of work before one-quarter of it is finished, and make up the back work, receiving full semester credit for all of the work of that semester, are not allowed a rebate in tuition. Non-matriculated students who enter upon any course or semester of work after one-quarter of it is completed, are allowed proportionate rebate of tuition.

The following schedule of charges for special courses will be applied, as based upon the semester hour credit to be granted, to all courses which are taken in excess of the semester hours scheduled for the class in which the student may be registered for any one year, whether such work is an advanced or other course required for graduation, an elective course, or one taken to make up a condition or a failure.

The same scale of charges will be applied to the courses in advanced algebra and solid geometry, taken by students to make good their matriculation conditions in these subjects.

Matriculated students taking less work than that represented by the semester hours scheduled for the class in which they may be registered will be charged the regular tuition; provided, that they are registered for at least fifteen (15) semester hours, otherwise their tuition will be based upon the schedule below.

Non-matriculated freshman and special students, taking from fifteen (15) to eighteen (18) semester hours of work per week pay the regular tuition; otherwise, their tuition is based upon the schedule below.

Any subject required to be taken over again in class, or by special arrangement with the Instructor, will be charged according to the schedule below as though it were special course.

Subjects which are required to be taken over in class, or, which are taken by special arrangement with the Instructor, are not to be included in the semester hours scheduled for the class in which the

student may then be registered; but, they will be charged separately as special courses, and in addition thereto, according to the schedule below.

An annual Gymnasium fee, of $2.50, will be charged all students, on and after September 10, 1907.

Graduation fee of $10.00 will be charged, beginning with class graduating, June, 1909.

Charges for Special Courses.

Courses of lectures, recitations and class room work: per semester hour, one hour, weekly for eighteen (18) weeks	$2.50
Shopwork, drafting, surveying, chemical and physical laboratories: per semester period, one three hour period weekly, for eighteen (18) weeks...	$5.40

Deposit.

To ensure the prompt return whenever required, and in good order, of chemical, physical and engineering apparatus and tools; of keys to lockers and drawing and laboratory tables; and to defray any incidental expenses incurred by breakage or injury to property, an annual deposit fee of $10.00, is required of all students. The unexpended balance will be returned at the end of the year.

Cost of Living.

Owing to the large number of inquiries of prospective students as to the cost of living in Potsdam, the following schedules have been compiled. Experience has shown that these values represent good average rates:

Rooms:	Single...	$1.00 to $1.50
	Double.....	1.00 to 2.50

	Table Board.	Board and Room.
Club rates..	$3.00 to $3.50	$3.50 to $4.00
Single rate..	3.25 to 4.00	4.00 to 4.50

Estimated Expenses for a School Year of Thirty-six Weeks.

Tuition...	$100.00	$100.00
Gymnasium fee...	2.50	2.50
Deposit fee...	10.00	10.00
Books, stationery and instruments...	30.00	40.00
Room and Board...	144.00	162.00
Washing and laundry...	12.50	17.50
	$299.00	$332.00

To the above estimate for a school year should be added traveling expenses, clothing and such miscellaneous items as depend largely upon individual habits and manner of living, which, from the actual experience of students may be kept within from $75 to $100 for the thirty-six weeks. There are no dormitories attached to the school.

LEVINUS CLARKSON SCHOLARSHIP.

At the Charter Day Exercises, held in the Assembly Hall of the School, March 19, 1906, in commemoration of the decennial anniversary of the granting of the Charter, the following communication was read, at the close of his address, by Hon. Edwin A. Merritt, LL.D., member of the Board of Trustees:

Thomas S. Clarkson Memorial School of Technology Scholarship.

We, the undersigned, agree to pay on Charter Day, March 19th, of each year, One Hundred Dollars, ($100) to be applied to the establishment of a Scholarship to be known as the "Levinus Clarkson Scholarship", and, to be awarded to a candidate nominated by the Director of said School.

Said Scholarship is further to be held only on condition of the attainment of an average standing in studies, and of deportment satisfactory to the School authority.

March 19, 1906. (Signed) Elizabeth Clarkson.
(Signed) Frederica Clarkson.

This Scholarship will be awarded to the student whose record is in every way above question, as based upon the work and deportment of previous years, and who gives the most promise of future professional success. The award will be made on Founder's Day, November 30, each year, and applied to the current college year.

STUDENT ORGANIZATIONS.

Clarkson Engineering Assembly. Out of the growing need for a rational consideration of the students' welfare, through student self-government by an elective representative assembly, co-ordinate with the Faculty administration, combined with the harmony and solidarity of all interests at the time of the decennial anniversary of the founding of the Institution, there has been evolved a type of organization in this assembly peculiarly adapted to aid and abet the training of men for the engineering profession at a School of Technology such as the Clarkson Memorial.

The aim and purpose of the Clarkson Engineering Assembly are clearly set forth in the following preamble to the Constitution, adopted at its first annual meeting, on the Decennial Founder's Day, November 30, 1906:

"We, the Faculty, Alumni, and students of the Thomas S.Clarkson Memorial School of Technology, in order more efficiently to promote the advancement of science, the dignifying of labor and the increase of good learning for which this Institution was established; to form a more perfect working union of all working forces, and promote the general welfare of this Institution; and further, to aid its growth and development in accordance with the wishes and purpose of its Founders for the promotion of the best interests of men and for the glory and praise of God, do establish this Constitution."

The organization of the Assembly was effected at that time to be composed of the members of the Faculty and of the instructional force appointed by the Board of Trustees; of two student members, each, an-

nually elected to represent the classes in the School; and of eight members of the Clarkson Tech. Alumni Association.

Young Men's Christian Association. In every educational institution, of college grade, there is the need of an organization that will weld all of the interests and bring into effective operation all of the forces that exist in the student environment making for righteousness and highest moral action, an organization that will uplife its members, raise the standard of the college, and keep before the students the value and the necessity of a Christian life. The college Young Men's Christian Association, now so fully established throughout the world, meets these requirements more fully than any other college organization. It is one whose sole aim is the moral betterment and spiritual uplift of the student life.

The students and members of the Faculty effected such an organization in the Clarkson School of Technology, October 10, 1904, with suitable committeemen appointed to arrange for inter-collegiate relations. The college Y. M. C. A. Constitution has been adopted. There are now fifteen active members. Meetings are held weekly throughout the college year. The topics for the meetings are those that deal with problems confronting every young man in college and which appeal to his highest motives and serve his best interests.

Clarkson Musical Association. This association is composed of the Glee Club, the Mandolin Club and Orchestra. It is organized under a Board of Directors, having in charge all matters pertaining to the Association, the Board comprising the officers of the Association annually elected, and those of the three musical clubs. The object of this association is to encourage and promote the musical talent of the student body, and to aid in developing in connection with it, the social life of the school community. The music for the Chapel exercises as well as for the official functions of the School, such as Founder's Day, Charter Day and those incident to the Commencement, is furnished by the Musical Association.

Clarkson Athletic Association. An Athletic Association is maintained by the students, under the management of which all forms of athletic sports are conducted. This association is supported by student subscriptions paid annually. It is an organization whose object is to promote the physical welfare and activities of the students by outdoor games and to encourage and maintain a proper spirit in favor of hearty manly sports.

The council of six members of the association is annually elected by the student body with which the committee of the Faculty on athletics holds advisory relations. The council has general supervision of all athletic sports and contests, passes upon eligibility of players, arranges the schedule of games, and seeks to foster honesty and fairness in all athletic sports. Each and every member of an athletic team representing the school in intercollegiate contests must be a regular accredited student. For details regarding membership in athletic teams, see the Tech. "Handbook".

Fraternities. The following fraternities have been organized at this institution: Omicron Pi Omicron, founded, November 9, 1903; and Sigma Delta, founded, March 17, 1904. They have been formed to enter unoccupied fields, to fill imperative needs for organizations that would bring the members of different classes together on a common plane. In this way they seek to unite the student body more

thoroughly than could be effected by any class organization. Their purpose is to promote harmony and good fellowship among their members and to maintain a high standard of manhood. Intellectual and moral qualifications are considered for membership and in this way an influence is exerted for the betterment of student work and life. Their activities are social and professional rather than literary, and the development of the fraternal spirit is their chief work.

RULES AND REGULATIONS.

Class Officers. All matters pertaining to the general welfare of the individual student; the arrangement of courses, studies and work; the withdrawal of books from the library; deportment, absences and reports, are primarily vested in the Class Officer, according to the following assignments: Students in chemical engineering to Prof. Williams; civil engineering to Prof. McLeod; electrical engineering to Prof. Brackett; mechanical engineering to Prof. Swift; all freshmen and sophomores to Prof. Michel; specials in engineering to committee, Director, chairman.

Registration. In all cases this must conform to the sequence of required work as indicated by the prerequisites of each course. No student will be allowed to register for more than twenty semester hours except by special permission of the Faculty.

Attendance. Regular attendance on school exercises, including chapel services, is expected of all students.

Reports. Reports of standings of all students are made to the Faculty at the middle and at the close of each semester. Copies of all reports are sent to each student's parent or guardian, except the mid-semester reports of standing of juniors and seniors.

Order. Good order and gentlemanly deportment are required as a condition of attendance.

Smoking is prohibited in the buildings and on the grounds of this School.

Full details of the organization and management of the school will be found in its "Handbook", published by the authority of the Board of Trustees. Copies of this will be mailed upon application to the Director.

REQUIREMENTS FOR ADMISSION.

The requirements for admission to all regular courses in the Clarkson School of Technology are established by the Regents of the University of the State of New York. The following excerpt* from the University rules sets forth the preparation required:

"No degree shall be conferred for completion of a course of study or on examination, unless the candidate has a preliminary general education, at least a four year high school course or its full equivalent as determined by University rules. Satisfactory evidence of such preliminary education must be offered before beginning the course of

*University of the State of New York, College Department, Annual Report 1898, Vol. I., p. 10.

study for the degree, and any condition or deficiencies (which must not exceed three academic subjects, i. e. 15 counts) must be made up within one year."

Matriculation, September, 1907.

Candidates for matriculation in this school must have complied with the above ruling. The standard required for the class entering September, 1907, is represented by a 63 count academic diploma, as below, such as granted by the New York State Education Department. Each "count" represents a lesson a week for a school year (see "Handbook 3," December, 1906, published by the New York State Education Department, Albany).

New York State Education Department Diplomas.

For applicants for admission to this Institution who present New York State Education Department diplomas, the following shows the grouping of required and elective work in the total of 63 counts, required for the academic diploma, June 1, 1907, and necessary for admission for the class entering September, 1907:

Required Subjects.	Counts.
English	10
Algebra	5
Intermediate Algebra	2
Plane Geometry	5
Solid Geometry	2
Science, Group 3*	7½
History and Social Science, Group 4*	7½
Counts in required academic subjects	39
Advanced Algebra, required for matriculation in Clarkson School of Technology	3
Counts in elective or optional academic subjects	21
Total academic counts required for matriculation	63

All credits earned before June 1, 1906, will be recorded as heretofore. When these credits are applied to credentials issued subsequent to June 1, 1906, their value will be increased 25 per cent (except in certain cases of equivalence), since 12 counts old are exactly equivalent to 15 counts new.

College Entrance Examination Board Certificates.

Applicants who have taken examinations under the auspices of the College Entrance Examination Board** will be granted such an academic equivalent certificate by the New York State Education Department, as may be represented by the high school work satisfactorily covered by these examinations. If the total work thus certified is equivalent to an academic diploma issued by the Department, as above,

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*List of academic subjects, p. 54. Also, Syllabus for Secondary Schools 1905; Secondary Education Bulletin 27, pp. 10-15, New York State Education Department, Albany.

**College Entrance Examination Board, Dr. Thomas S. Fiske, Secretary, P. O. Sub-station 84, New York, N. Y.

and including advanced algebra and solid geometry the applicant will be admitted to matriculation in this school without further examination.

Accredited Academic Certificates and Diplomas.

Candidates not holding Department certificates and those from other states and from Canada, or who have attended schools in this state not registered by the Education Department, will present their credentials to the Director upon making application for admission. The extent of their preparation may be compared to the New York State standard by an inspection of the list of academic studies below. The applicant's credentials will be forwarded to and examined by the New York State Education Department. If the preparation is found to be equivalent to a four year high school course, as represented by the academic diploma issued by the Department, as above, and including advanced algebra and solid geometry, it will issue without examination the necessary credential admitting the candidate to matriculation in this Institution.

Notes on Matriculation.

If advanced algebra and solid geometry are not included in the accepted certificate, the candidate for admission will be matriculated as conditioned in these subjects. Such conditions may be removed by special examination in the Institution at the time of entrance.. During their freshman year, however, students may take advanced algebra and solid geometry in special classes at the school; provided, that they have attained such advanced standing in other subjects as will warrant this procedure; and the condition may be removed upon passing the required examinations in these subjects.

Blank form of application for academic equivalent certificates, for admission to this School of Technology, will be forwarded upon application to the Director.

Matriculation, after September, 1906.

Hitherto 12 counts have been given for a year's work of 15 lessons a week—48 counts for a diploma. Hereafter 18 counts will be given for a year's work of 18 lessons a week—72 counts for a diploma, tested by Examinations, of New York State Education Department.

The proposed increased requirement of 18 lessons a week will go into operation in September, 1905, but is not to be retroactive. Therefore the number of counts required under the new scheme of values for an academic diploma will be as follows:

To June 1, 1906... . ...48 counts
Between June 1, 1906, and June 1, 1907... ... ...63 counts
Between June 1, 1907, and June 1, 1908... ... ...66 counts
Between June 1, 1908, and June 1, 1909... ... ...69 counts
June 1, 1909, and thereafter... ... ...72 counts

All credits earned before June 1, 1906, will be recorded as hitherto. When these credits are applied to credentials issued subsequent to June 1, 1906, on New York State Education Department examinations, their value will be increased 25 per cent. since 12 counts under one scheme of values are exactly equal to 15 under the other.

The requirements for the academic diploma which is issued only to students taking the Department's preliminary and academic examinations, are as follows: English 13 credits, mathematics 10, history

6; science 10, elective 33. For the classical academic diploma: English 13 credits, mathematics 10, history 5, science 5, Latin 20, a second foreign language 15, elective 4. These new requirements go into effect June 1, 1909.

September Examinations for Matriculation. Academic examinations for matriculation in the Thomas S. Clarkson Memorial School of Technology will be held in the Institution, in September, of each year, under the rules and regulations* of the New York State Department of Education, and under its auspices. These examinations are set according to the following daily program for 1907:

September 25 Wednesday 9.15 a. m.	September 26 Thursday 9.15 a. m.	September 27 Friday 9.15 a. m.
Advanced arithmetic German, 1st year Latin, 1st year El. algebra	German, 2nd year Plane geometry Physics El. United States history and civics.	German, 3rd year Arithmetic American history and civics Stenography Caesar Latin grammar El. Latin comp.
1.15 p. m.	1.15 p. m.	1.15 p. m.
English, 1st year English, 2nd year English, 3rd year 1905 Syl. Advanced English English composition Psychology and prin. of education.	French, 1st year Physiology and hygiene Economics El. bookkeeping Chemistry	Physical geography History of Great Britain and Ireland Civics Typewriting Drawing History and principles of education.

Candidates seeking admission to these examinations, whether with view to entering the Institution, or to make up academic conditions, after entrance, should make application of the Director, at least ten days in advance, stating at what time and in what studies they wish to be examined.

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*State of New York Education Department, Handbook 3, Examinations 1905-10; Examinations Division, State Education Department, Albany, N. Y.

ACADEMIC SUBJECTS.*

Group I—Language and Literature.

ENGLISH

(4 First year English)
(3 Second year English)
3 Third year English
3 Fourth year English
2 English grammar
2 History of the English language and literature

ANCIENT

(5 First year Latin)
1 Latin grammar
1 Elementary Latin composition
3 Caesar
4 Cicero
4 Virgil
1 Latin composition
1 Translation of prose at sight
1 Translation of poetry at sight
(5 First year Greek)
1 Greek grammar
1 Elementary Greek composition
3 Anabasis
3 Iliad
1 Greek composition
1 Translation of prose at sight
1 Translation of Homer at sight

MODERN FOREIGN

(5 First year German)
5 Second year German (Elementary)
5 Third year German (Intermediate)
5 Fourth year German (Advanced)
(5 First year French)
5 Second year French (Elementary)
5 Third year French (Intermediate)
5 Fourth year French (Advanced)
(5 First year Spanish)
5 Second year Spanish (Elementary)
5 Third year Spanish (Intermediate)

Group II—Mathematics.

2 Advanced arithmetic
5 Elementary algebra
2 Intermediate algebra
3 Advanced algebra
5 Plane geometry
2 Solid geometry
2 Trigonometry

Group III—Science.

5 Physics
5 Chemistry
5 Biology
2½ Elementary botany
2½ Elementary zoology
2½ Physiology and hygiene
5 Advanced botany
5 Advanced zoology
5 Physical geography

Group IV—History and Social Science.

3 or 5 Ancient history
3 or 5 European history
3 or 5 History of Great Britain and Ireland
5 American history with civics
2 Civics
2 Economics

Group V—Business Subjects.

4 Elementary bookkeeping
3 Advanced bookkeeping
2 Business practice and technics
2 Business arithmetic
2 Commercial law
2 History of commerce
3 Commercial geography
2 Business correspondence
1 Business writing
3 Stenography (50 words)
3 Stenography (100 words)
2 Typewriting

Group VI—Other Subjects.

3 History and principles of education
3 Psychology and principles of education
3 Drawing
3 Advanced drawing (General)
2 Advanced drawing (Art)
2 Advanced drawing (Mechanical)
2 First year home science
2 Second year home science
2 First year shopwork
2 Second year shopwork
3 Agriculture

The numerals prefixed to the subjects in the above list indicate the number of lessons a week for a year and also the number of counts to be earned thereby.

*Syllabus for Secondary Schools 1905. Secondary Education Bulletin 27, pp. 11-12. New York State Education Department, Albany.

Admission to Advanced Standing.

Undergraduates from other institutions, to be admitted as regular students in the sophomore or junior class of any course, must first meet the academic requirements for matriculation of the corresponding freshman year of that class, page 102. Blank forms of application for academic equivalent certificates for admission to this Institution, will be forwarded upon request to the Director.

The candidate will then be required to pass satisfactory examinations in the subjects given at this Institution in the preceding year; or, to furnish satisfactory evidence of having completed the equivalent work of the earlier years by presenting certificates of the same or similar work done in other colleges or technical schools. These certificates must be clear and definite with regard to subjects taken, ground covered, length of course in weeks and periods per week; and, methods of instruction pursued, recitations, lectures, laboratory, etc., with standing in proficiency attained. Blank forms of application for admission to advanced standing will be forwarded upon request to the Director.

In determining the status of applicants for advanced standing the earlier work thus submitted will be measured on the semester hour basis, below, and compared to the standards and courses of this Institution, set forth in the requirements for the degree, pages 107-109. The credit to be given such earlier work, and thence embodied in the recommendations of the Faculty for the degree, according to the rules of the University of the State of New York, can only be determined after the work of the applicant has been submitted to the Faculty through the report of the professor concerned.

The applicant is also required to file with the Director a certificate of honorable dismissal from the institution last attended.

Admission of Special Students.

Special students who furnish, by examination or certificate, satisfactory evidence of sufficient and thorough preparation will be admitted to such regular courses as they may be qualified to pursue to advantage. Special courses of study may be arranged subject to the approval of the Faculty.

Special students not attending another school or otherwise engaged in outside work, must register for at least ten semester hours, but are not allowed without permission of the Faculty to register for more than eighteen semester hours of class-room and practical work per week.

REQUIREMENTS FOR GRADUATION.

Basis of Credit.

Credit toward graduation is given in the several courses on the following basis: One semester-hour credit is given for one lecture or recitation, per week, for a semester of eighteen weeks; or for a practice period of three hours per week for the same length of time. The total work of the four years, as required for the baccalaureate degree, is equivalent to one hundred and forty-two semester hours.

To be entitled to graduate the candidate must have satisfactorily completed all of the prescribed and elective work of the given course,

and will be required in addition to pass all final examinations which may be given on subjects relating particularly to the course. No student can be recommended to the Trustees as a candidate for graduation till all dues to the school have been settled, and the accepted type-written copy of the thesis, where the same shall have been elected, placed in the library of the Institution.

Theses.

Candidates for graduation may present a thesis in lieu of the equivalent of five semester hours of practical instruction and work in laboratory, workshop, field or drafting room, singly or combined. Such a thesis should embody the results of scientific work, experiment and investigation along the lines represented by their respective courses and deal in a competent manner with problems similar to those arising in professional work. The topic selected should be well within the power of the student to elaborate in the time allowed. The title and completed thesis must be submitted to the head of that department from whose course the student is to graduate. The type-written copy of the thesis should be prepared according to the specifications for theses adopted by the Faculty. (See the "Handbook").

Degrees.

All candidates for graduation who satisfactorily complete the regular four year courses of study and the examinations required, and who have been recommended by the Trustees of this school to the Regents of the University of the State of New York for the degree of Bachelor of Science, receive from the University the degree of B.S., in the course pursued: namely, chemical, civil, electrical, or mechanical engineering. This degree is certified by a diploma bearing the seals and official signatures both of this institution and of the University of the State of New York.

Schedules of Requirements for Graduation.

In the following schedules where the subtitle of each course is given, it is followed (in parenthesis) by the name and number of the course of instruction under which its description will be found; thus, "Coal Analysis (Chemistry 25)" is described, with the days and hours assigned, under "Chemistry," course 25, which is "Coal Analysis."

If a number immediately follows any course, as "English 1," it implies that there is no subtitle; and its description is given under that title, in this case under "English."

The semester-hour credit of each course is given in the right-hand column. The usual abbreviations are used for the engineering courses of instruction: C. E., civil engineering; E. E., electrical engineering; M. E., mechanical engineering.

Requirements for the Baccalaureate Degree.

The following requirements for the first two years are common to the four courses leading respectively to the degree of Bachelor of Science in Chemical, Civil, Electrical and Mechanical Engineering:

Freshman Year.

I. Semester.

	Semester hours per week
English 1	2
French 1 or German 1	5
Trigonometry (Math. 2)	4
Chemistry 1	4
Mechanical Drawing (Drawing 31)	2
Woodworking (Shopwork 3)	1
	18

II. Semester.

	Semester hours per week
English 2	2
French 2 or German 2	5
Analytic Geometry (Math. 4)	2
Calculus (Math. 12)	2
Qualitative Analysis (Chemistry 2)	4
Elem. of Eng'g Construction (M. E. 8)	2
Woodturning (Shopwork 6)	1
	18

Sophomore Year.

English or History (Elective)	2
Calculus (Math. 5)	3
Analytic Geometry (Math. 13)	2
Physics 1	5
Physical Laboratory (Physics 21)	1
Descriptive Geometry (Drawing 33)	2
Surveying (C. E. 1)	1
Forging (Shopwork 4, 5)	2
	18

Economics 1	2
Differential Equations (Mechanics 3) / Theoretical Mechanics (Mechanics 1)	5
Physics 2	5
Physical Laboratory (Physics 22)	1
Elements of Mechanism (M. E. 11)	2
Surveying (C. E. 2)	1
Machine Work (Shopwork 10)	2
	18

Requirements for the Degree of Bachelor of Science in Chemical Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Economics 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) } Applied Mechanics (Mechanics 2) }	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
Dynamos and Motors (E. E. 1)	3	Iron Analysis (Chemistry 24)	1
Electrical Laboratory (E. E. 21)	1	Metallurgy of Iron and Steel (Mining 5)	1
Heat Engines (M. E. 13)	4	Mineralogy (Mining 3)	3
Organic Chemistry (Chemistry 3)	4	Quantitative Analysis (Chemistry 20)	2
		Heat Engines (M. E. 13)	2
		Industrial Chemistry (Chemistry 4)	4
	18		18

Senior Year.

Laws of Operation and Contracts, (Economics 5, 6)	2	Engineering Economics (Economics 2)	1
Coal Analysis (Chemistry 25)	1	Assaying (Mining 26)	1
Water Analysis (Chemistry 23)	1	Organic Chemistry (Chemistry 27)	2
Cement Testing (Chemistry 28)	1	History of Chemistry (Chemistry 5)	1
Advanced Quantitative Analysis	2	Electro-Chemistry (Chemistry 6)	2
Physical Chemistry (Physics 4)	2	Seminar	1
Electrical Laboratory (E. E. 23, 24)	1	Thesis	5
Electrical Machinery (E. E. 6)	4	Elective	4
Seminar	1		
Chemical Preparations	2		
	17		17

Civil Engineering.

Junior Year.

I. Semester.		II. Semester.	
Economics of Industry (Economics 3)	1	Economics of Manufactures (Econ. 4)	1
Theoretical Mechanics (Mechanics 4) } Applied Mechanics (Mechanics 2) }	4	Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1	Experimental Mechanics (M. E. 20)	1
Dynamos and Motors (E. E. 1)	3	Metallurgy of Iron and Steel (Mining 5)	1
Electrical Laboratory (E. E. 21)	1	Mineralogy (Mining 3)	3
Heat Engines (M. E. 13)	4	Heat Engines (M. E. 13)	2
Mechanical Engineering Lab'y (M.E. 23)	1	†*Alternating Currents (E. E. 4)	3
†*Railroads (C. E. 4, 25, 36)	3	Electrical Laboratory (E. E. 22)	1
		Elective	3
	18		18

Senior Year.

Laws of Operation and Contracts, (Economics 5, 6,)	2	Engineering Economics (Economics 2)	1
Water Analysis (Chemistry 23)	1	Railway Economics (Economics 9)	1
Cement Testing (Chemistry 28)	1	Assaying (Mining 26)	1
Bridges and Roofs (C. E. 5)	3	Structural Design (C. E. 6)	3
Graphic Statics (C. E. 35)	1	† { Masonry and Foundations (C. E. 8) } { Municipal Engineering (C. E. 11) }	3
†Municipal Engineering (C. E. 10)	3	Geodesy (C. E. 3)	2
Astronomy (C. E. 18)	1	Thesis, or Elective	5
Mining (Mining 4)	2	Hydraulic Motors (C. E. 12)	1
Elective	3		
	17		17

†Seniors and Juniors unite in these subjects. *Not taken in 1907–1908.

Requirements for the Degree of Bachelor of Science in Electrical Engineering.

Junior Year.

I. Semester.

Economics of Industry (Economics 3)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2)	4
Experimental Mechanics (M. E. 20)	1
Dynamos and Motors (E. E. 1)	3
Electrical Laboratory (E. E. 21)	1
Heat Engines (M. E. 13)	4
Kinematics (M. E. 1)	1
Machine Drawing (Drawing 34)	2
Gas and Oil Analysis (Chemistry 21, 22)	1
	18

II. Semester.

Economics of Manufactures (Econ. 4)	1
Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1
Iron Analysis (Chemistry 24)	1
Metallurgy of Iron and Steel (Mining 5)	1
Alternating Currents (E. E. 4)	3
Electrical Laboratory (E. E. 22)	1
Heat Engines (M. E. 13)	2
Machine Design (Drawing 36)	2
Pattern Making (Shopwork 7)	1
Foundry (Shopwork 9)	1
Seminar (E. E. 16)	1
	18

Senior Year.

I. Semester.

Laws of Operations and Contracts, (Economics 5, 6,)	2
Coal Analysis (Chemistry 25)	1
Electrical Machinery (E. E. 6)	4
Electrical Laboratory (E. E. 23, 24)	1
Gas Engines (M. E. 7)	1
Steam Turbines (M. E. 15)	1
Mechanical Eng'g Lab'y (M. E. 23)	1
Graphic Statics (C. E. 35)	1
Mechanical Construction (Shopwork 12)	3
Seminar (E. E. 16)	2
	17

II. Semester.

Engineering Economics (Economics 2)	1
Electric Transmission (E. E. 8)	4
Railway Economics (Economics 9)	1
Gas Engines (M. E. 7)	1
Mechanical Eng'g Lab'y (M. E. 23)	1
Thesis or Elective	5
Seminar (E. E. 16)	1
Elective	3
	17

Mechanical Engineering.

Junior Year.

I. Semester.

Economics of Industry (Econ. 3)	1
Theoretical Mechanics (Mechanics 4) / Applied Mechanics (Mechanics 2)	4
Experimental Mechanics (M. E. 20)	1
D. C. Dynamos and Motors (E. E. 1)	3
Electrical Laboratory (E. E. 21)	1
Heat Engines (M. E. 13)	4
Kinematics (M. E. 1)	1
Machine Drawing (Drawing 34)	2
Gas and Oil Analysis (Chemistry 21, 22)	1
	18

II. Semester.

Economics of Manufactures (Econ. 4)	1
Hydraulics (Mechanics 3)	3
Experimental Mechanics (M. E. 20)	1
Iron Analysis (Chemistry 24)	1
Metallurgy of Iron and Steel (Mining 5)	1
Alternating Currents (E. E. 4)	3
Electrical Laboratory (E. E. 22)	1
Heat Engines (M. E. 13)	2
Machine Design (Drawing 36)	2
Pattern Making (Shopwork 7)	1
Foundry (Shopwork 9)	1
Elective	1
	18

Senior Year.

I. Semester.

Laws of Operation and Contracts (Economics 5, 6)	2
Coal Analysis (Chemistry 25)	1
Advanced Testing Materials (M. E. 21)	1
Machine Design (Drawing 37)	2
Steam Turbines (M. E. 15)	1
Mech. Eng'g. Laboratory (M. E. 23)	1
Kinematics (M. E. 12)	2
Graphic Statics (C. E. 35)	1
Mechanical Construction (Shopwork 12)	3
Gas Engines (M. E. 7)	1
Elective	2
	17

II. Semester.

Engineering Economics (Economics 2)	1
Structural Design (C. E. 6)	2
Railway Economics (Economics 9)	1
Mech. Eng'g Conference (M. E. 16)	1
Mech. Eng'g. Laboratory (M. E. 23)	1
Gas Power Plants (M. E. 31)	1
Valve Gears (M. E. 2)	1
Steam Power Plants (M. E. 32)	2
Thesis	5
Elective	2
	17

DESCRIPTION OF THE COURSES OF INSTRUCTION.

The school year is divided into two semesters, of eighteen weeks each, including the time for the final examinations. The daily periods or "hours" for lectures, recitations and class-room instruction are of 55 minute intervals and each will probably require two hours of home preparation. The practice periods for instruction in laboratories, drafting rooms, shops, and field work, consist of three actual hours.

Credit toward graduation is given in the several courses on the following basis: one semester-hour credit is given for one lecture or recitation per week, for a semester of eighteen weeks; or for a practice period of three hours per week for the same length of time.

In the following description of the courses of instruction, they are arranged in alphabetical order and designated by the name of the department and the number of the particular course. Thus, the first course in Chemistry is known as "Chemistry 1." After the description of each course there is stated the prerequisite or requirement, if any, for admission to it.

The semesters,—I. or II.; days of the week,—M., T., W., Th., F., S.; hours of the day,—1, 2, 3, 4, 5, 6, 7; and semester-hour credit (Arabic figure in parenthesis) are then noted; for example, "Chemistry 1, I.; W., F., 4; M., 5, 6, 7; S., 2, 3, 4; (4)." This indicates that the course in general chemistry is given during the first semester, by lectures and class-room work, on Wednesdays and Fridays at the fourth hour; and is accompanied by laboratory practice on Mondays during the fifth, sixth and seventh hours, and on Saturdays during the second third and fourth hours; and a credit of four semester hours will be allowed on this course.

Courses given during a portion of a semester,—as Chemistry 21, I., first nine weeks; M., 5, 6, 7; (½)" are reduced to the standard semester-hour basis for credit. When a course extends through both semesters,—I. and II., the semester-hour credit given is that for one semester only.

Whenever the hour or time at which classes are held is not specified, it is subject to such arrangements as may be found necessary at the beginning of each semester.

The professor in charge of each department gives the instruction in the several courses announced for that department unless otherwise stated.

Courses of instruction which are not given during 1907-1908 are designated by numbers enclosed within brackets thus [32].

The following abbreviations are used in referring to the prerequisites in the engineering departments of instruction: C. E., civil engineering; E. E., electrical engineering; M. E., mechanical engineering.

Electives. Courses preceded by an asterisk (*) are not required for graduation in any of the four year schedules, but are entirely elective. They are offered in the departments of Electrical Engineering, English, History, Mechanical Engineering and Modern Languages and include thesis electives as explained on page 106. Electives may be chosen from regular courses, subject to the approval of the Class officers, but are given only on condition that at least three students take the same. No extra charge is made for any elective courses unless

they are taken in excess of the total semester hours scheduled for the class in which the student may be registered for any one year.

CHEMISTRY.

Professor Williams.

1. **Chemistry.** Fundamental principles of the science, including study of nonmetallic and metallic elements, with particular attention to their industrial and commercial relations. Discussions upon the recent developments in chemical theory and practice serve to keep the student in touch with the rapid advances of modern chemistry.

Instruction is given by means of lectures, by assigned reference work in standard books of chemistry, and by recitations; all this being supplemented by intelligent work in the laboratory. Frequent examinations serve to make the student's knowledge of the subject definite and specific.

The work in general chemistry is taken up in the following order:

Non-metals. Matter, forces, chemical and physical changes, classification of elements, hydrogen and oxygen with their compounds, acids, salts and bases. Study of the individual members of the chlorin, sulfur, nitrogen and carbon groups, exercises in the solution of chemical problems.

Metals and Metallurgy. Metals and non-metals compared, the Periodic System as a basis for grouping the elements, study of the individual members of the potassium, calcium, aluminum, lead, iron, magnesium and platinum groups, and the common methods of extraction of the metals from their ores. I:; W., F., 4; M., 5, 6, 7; S., 2, 3, 4. (4).

2. **Qualitative Analysis.** While instruction in the metallic elements and their compounds is given by lectures and recitations, this course is chiefly devoted to practical work in the laboratory. A number of analyses of the more important minerals and metallic substances are made.

The work includes the determination of the various bases in both simple and compound solutions, together with the acid radicals. In addition to the analysis of solutions, practice in the use of the blowpipe and the other methods of dry analysis. Prerequisite, Chemistry 1. Lectures, recitations and laboratory work. II.; W., F., 4; M., 5, 6, 7; S., 2, 3, 4; (4).

3. **Organic Chemistry.** Study of fundamental principles of organic chemistry, including detailed consideration of the methane and benzene series of hydrocarbons, alcohols, ethers, aldehydes, ketons, fats and oils, saponification, starches, sugars, substitution products, aniline dyes, indigos and alkaloids. Special attention is paid to the chemical structure and methods of preparation of those compounds having practical industrial value. Prerequisite, Chemistry 1. Lectures, recitations and laboratory work. I.; M., W., S., 1; F.. 1, 2; (4).

4. **Industrial Chemistry.** Study of the various technical methods used in the commercial manufacture of chemical products: sulphuric, hydrochloric and nitric acids, ammonia, potash and fertilizers, glass and pottery, lime and cement, paints, coal tar products, mineral oils, sugar starch, glucose and fermentation industries, textiles, paper, leather, glue, etc. Instruction is given by lectures assigned text-book work and laboratory practice. Prerequisite, Chemistry 1. II.; (4).

5. **History of Chemistry.** Assigned reference work and the preparation of papers and biographical sketches of noted chemists with their particular achievements, II.; (1).

6. **Electro-Chemistry.** Study of electro-chemical constants, chemical analyses by electrolysis, construction and operation of various types of electrical furnaces and their commercial products. Reference and laboratory work. II.; Arrange time; (2).

20. **Quantitative Analysis.** Quantitative separation and determination of the more important bases and acids by gravimetric, volumetric and electrolytic methods, including calibration of glass ware and other apparatus. After thorough mastery of general principles of quantitative analysis, choice of practical work is allowed, adapted to the needs of the individual student. Prerequisite, Chemistry 2. Required of students specializing in Chemistry. Lectures and laboratory. I. and II.; (2).

21. **Gas Analysis.** Proper selection of samples of flue and illuminating gases, determination of constituents, deductions from the results of analysis. Given with the standard apparatus of Hempel, Orsat, Winkler, Lunge, etc. Calculation of heating value of fuel gases. Prerequisite, Chemistry 2. Laboratory work. I., first nine weeks; W., 5, 6, 7; (½).

22. **Oil Analysis.** Determination of the composition and purity of burning and lubricating oils, and the adaptability of various oils to particular requirements. Prerequisite, Chemistry 2. Lectures and laboratory. I., last nine weeks; W., 5, 6, 7; (½).

23. **Water Analysis.** This work includes the sanitary analysis of samples of drinking water, together with the microscopic examination of the same and the determination of the fitness of water to be used in boilers. In connection with the latter, chemical analyses are made of boiler scale. Accompanying the laboratory work in water analysis, lectures are given upon the interpretation of the results of analysis, on the various methods for the purification and softening of water supplies, and the disposal of sewage. Prerequisite, Chemistry 2. Lectures and laboratory. I.; M., 5, 6, 7; (1).

24. **Iron Analysis.** Technical methods for the determination of percentage of iron in ores, of silica, sulfur, phosphorus, combined and graphite carbon in iron and steel. In this course, attention also is given to the microscopic examination of iron and steel, accompanied by work in the selection and polishing of specimens, the microscopic examination and identification of constituents, and the making of microphotographs. Prerequisite, Chemistry 2. Laboratory course. II.; Tu., 5, 6, 7; (1).

25. **Coal Analysis.**

(a) Appropriate Analysis. Collection of average sample, determination of percentage of moisture, volatile matter, fixed carbon and ash.

(b) Organic Chemical Analysis. Determination of nitrogen, hydrogen, oxygen, sulfur, carbon and ash by the ordinary combustion methods. Deduction of theoretical heat value of coal and other fuels from the results of chemical analysis.

(c) Direct determination of heat value of fuels by combustion in Mahler bomb calorimeter. This work serves as a valuable

check upon the theoretical computations from the results of chemical analyses. Prerequisite, Chemistry 2. Laboratory course I.; Th., 5, 6, 7; (1).

27. Organic Chemical Analysis. Quantitative determination of carbon, hydrogen, oxygen, sulfur and nitrogen by the ordinary methods of ultimate analysis; calculation of chemical formulae from results of analysis and molecular weight determinations; practical applications in the analysis of various food products including milk, flours, starches, sugars, baking powders, etc. Prerequisites, Chemistry 2, 3. Laboratory. II.; Th., 1, 2, 3; F., 1, 2, 3; (2).

28. Cement Testing. Discussions upon methods of manufacture and uses of various types of cement. Chemical analysis. Laboratory tests of tensile strength, fineness, specific gravity, time of setting, tendency to checking and cracking, etc. Special investigation of the strength of reinforced concrete and structural forms of concrete steel. Lectures and laboratory work. I.; (1).

CIVIL ENGINEERING.

Professor McLeod.

1. Surveying. Use and adjustment of engineering instruments; the engineer's transit; the engineer's level; the needle compass. Field problems involving the use of transit or compass and of the steel tape; differential and profile leveling; land surveying. Prerequisites, Math. 2, Drawing 31. Recitations and problems, field work, drafting, and computations. I.; Th., 5, 6, 7; (1).

2. Surveying. Topographical surveying by the transit and stadia; contour maps; hydrographic surveying; city surveying. Prerequisite, C. E. 1. II.; Th., 5, 6, 7; (1).

3. Geodesy. Historic outline; triangulation, reconnaissance and signals; instruments and observing; base line measurement; trigonometric and precise leveling; figure of the earth; geodetic position. II.; T., Th., 1; (2).

[4.] Railroads. Reconnaissance surveys; preliminary and location surveys; profile levels; topography; cross sectioning; estimates; vertical curves; equating for curvature; the virtual profile. Lectures, recitations and problems. I.; arrange time; (1).

5. Bridges and Roofs. Computation of stresses in bridge and roof trusses; highway and railway bridge trusses; deflection and internal work. Prerequisite, Mechanics 2. Recitations, computations, reports, and drafting. I.; T., Th., 4; (3).

6. Structural Design. Principles of economic design; design of plate girder bridge, pin bridge, riveted bridge; class-room designs; continuous bridges, draw bridges, cantilever bridges, suspension bridges, arches; building construction. Prerequisite, C. E. 5. Lectures, problems, computations and drafting. II.; M., 4, 5, 6, 7; T., 5, 6, 7; (3).

8. Masonry and Foundations. Building stone, retaining and reservoir walls and dams, arches; mechanics of masonry construction; foundations on land and water; coffer dams, caisson and crib dams; pneumatic caissons. Prerequisite, Mechanics 3. Lectures and recitations. II.; T., W., Th., 4; (1½).

10. Municipal Engineering. Construction and maintenance of city streets and country roads; study of pavements and paving materials; construction of sewers; sewage disposal and destruction; house plumbing. Prerequisites, C. E. 2, Mechanics 3. I.; M., W., F., 4; (3).

11. Municipal Engineering. A continuation of C. E. 10. Hydrography; surface and underground waters; reservoirs; water supply; methods of filtration and distribution. Prerequisite, C. E. 10. II.; T., W., Th., 4; (1½).

12. Hydraulic Motors. Gravity motors; impulse wheels; turbine and reaction wheels; centrifugal and turbine pumps; pressure engines, accumulators, and hydraulic rams. Assigned reading, and class problems. II.; W., 2; (1).

18. Astronomy. Fundamental principles of spherical astronomy; the celestial sphere; special fundamental planes and their associated concepts; spherical co-ordinates and the transformation of spherical co-ordinates; solar and sidereal time and the general measure of time; parallax and semi-diameter; aberration; astronomical refraction; precession and nutation; the construction and use of the sextant; time by equal altitudes of a fixed star and by equal altitudes of the sun; time by single altitude of a fixed star and by single altitude of the sun; geographical latitude by a meridian altitude of a star or of the sun, and by an altitude of a star, the time being known; methods of determining terrestrial longitude. I.; W., 2; (1).

[25.] Field Practice. Reconnaissance, preliminary and location surveys; work with transit, level, rod and chain. I.; first nine weeks, Saturdays, (6 actual hours each); (1).

35. Graphic Statics. General principles of the force and equilibrium polygons; determination of reactions and stresses of roof and bridge trusses; center of gravity and moment of inertia; the course is intended to supplement Civil engineering 5, Bridges and Roofs. Prerequisites, Drawing 31 and Mathematics 2. I.; W., 5, 6, 7; (1).

[36.] Drafting. Plans and profiles of lines surveyed in course 25. I.; second nine weeks (6 actual hours per week); (1).

[37.] Design of a Reinforced Concrete Arch. The design consists of four investigations, exclusive of the design of the centering. The method of design is partly analytical and partly graphical. Lectures, computations, drawings and reports. II., W., 2, 3, 4, 5, 6, 7; (2).

DRAWING AND DESIGN.

31. Mechanical Drawing. The use of instruments; geometric drawing; elementary mechanical drawing; the foundation for subsequent work in drawing and design. Prerequisite, plane geometry. Lectures and drawing. I.; T., Th., 3, 4; (2). Professor Swift.

32. Advanced Mechanical Drawing. Isometric and other methods of projection than the orthographic; linear perspective; shades and shadows; applications in engineering and building construction, structural and architectural work, conventional details and symbols; color work. II.; arrange time; (2). Professor Swift.

33. Descriptive Geometry. Elementary principles; problems relating to points, lines, planes and solids; intersections of planes. Pre-

requisite, Drawing 31. Drawing and problems. I.; W., 2; F., 5, 6, 7; (2). Professor Graffam.

34. **Machine Drawing.** Freehand detail sketches of different parts of a given machine; working drawings; tracing and blue printing; assembly drawings made from details. Prerequisite, Drawing 31. I.; M., F., 5, 6, 7; (2). Professor Swift.

36. **Machine Design.** Freehand detail drawings; working drawings, including tracing and assembly drawings; also design of some part of a machine or of an engine from specifications, by the use of hand books. Prerequisite, Drawing 34. II.; W., 3, 4; Th., 5, 6, 7; (2). Professor Swift.

37. **Machine Design.** Study of the principles underlying the designing of machinery, with application to the complete designing of some unit; comprising a calculation of all the stresses and the necessary distribution and arrangement of metal to withstand them; design of horizontal tubular boiler, fly-wheels, shafting, couplings, pulleys, etc. Prerequisites, Drawing 36, Mechanics 2. I.; (2). Professor Swift.

[41.] **Technical Photography.** A study of apparatus, optics of photography, exposure, developers, fixers, dry plates, developing papers printing-out papers, toning, blue-print processes, VanDyke solar process, lantern slide making, progress photographs of engineering structures, etc. Lectures and laboratory practice. Prerequisites, Chemistry 1, Physics 1. II., arrange time; (1). Professor McLeod.

ECONOMICS.

For reference to details of the courses offered there have been grouped under this general heading the discussions of legal and customary regulations bearing upon the engineering construction and professional practice, as outlined in the following courses: 2, 5 and 6. In these courses the study of the text is accompanied with lectures and collateral reading, the preparation of papers and reports.

1. **Economics.** Principles of economics and outlines of economic theory with reference to their applications in modern business, commerce and trade; capital and labor and their organization. Lectures, recitations, reports. II.; T., Th., 4; (2). Director Aldrich.

2. **Engineering Economics.** Specifications, estimates and appraisals; economics of the development and execution of engineering projects; employment of engineers and the ethics of engineering practice. Prerequisite, Economics 6. Texts, Johnson, Wait. II., first nine weeks; T., Th., 3; (1). Director Aldrich.

3. **Economics of Industry. An** economic study of the **resources** of engineering industries and of their development and utilization. Prerequisite, Economics 1. Lectures, reports. I.; Fr., 1; (1). Director Aldrich.

4. **Economics of Manufactures.** A study of modern methods of workshop production, from the design to the finished product; details of standardization, duplication and interchangeability of machine elements; shop accounting, systems and organization for economic production and distribution. Lectures and reports. II.; M., 4; (1). Professor Graffam.

5. **Laws of Operations.** A study of the law of operations preliminary to construction in engineering; discussion of the rights and privileges incident to the ownership of real property, water rights boundaries and power developments; and the rights of way for railways. Prerequisite, Economics 3. Text, Wait. I., first nine weeks; W., 3; F., 1; (1). Director Aldrich.

6. **Laws of Contracts.** A study of the laws of construction as related to contracts, bids and bidders. Prerequisite, Economics 5. Texts, Johnson, Wait. I., last nine weeks; W., 3; F., 1; (1). Director Aldrich

9. **Railway Economics.** A study of some of the engineering and economic features of traction and transportation problems, on steam and electric railroads. Prerequisite, Economics 3. Lectures and reports. II., second nine weeks; T., Th., 3; (1). Director Aldrich.

ELECTRICAL ENGINEERING.

Professor Brackett.

1-2. **Direct Current Dynamos and Motors.** The theory, construction and operation of continuous current generators and motors. Prerequisite, Physics 2. Lectures and recitations. I.; M., W., F., 2; (3).

3. ***Telegraphy and Telephony.** Methods of land and submarine telegraphy; the theory of the telephone; systems and instruments used in telephone engineering. Laboratory work in capacity and induction measurements, and the experimental determination of the properties of lines and cables. An elective course offered to any class of senior electrical students that may desire work in this special line. Prerequisites, E. E. 1, 4. Lectures. II.; Tu., Th., 2; (2).

4. **Alternating Currents.** Study of the theory of alternating currents by graphical and analytical methods. Inductance, capacity, impedance, etc. Methods of computation and measurement. Prerequisite, E. E. 1. Recitations and problems. II.; M., W., F., 2; (3).

6. **Electrical Machinery.** Course on the theory, construction, regulation and operation of single and polyphase generators, motors, transformers and rotary converters; and the comparative design of direct current and alternating current machinery. Prerequisite, E. E. 4. I.; M., T., Th., F., 4; (4).

7. ***Electrical Distribution.** The methods for economical distribution of electrical energy for light and power purposes; insurance rules and regulations. Prerequisite, E. E. 4. Lectures and problems. II.; W., 4; (1).

8. **Electric Transmission.** Alternating-current transmission of power, characteristics and properties of transmission lines construction, protection, management; economics of design and regulation; single and polyphase systems; high-potential and long-distance applications. Prerequisite, E. E. 6. Lectures and problems. II.; M., Tu., Th., F., 4; (4).

9. ***Electric Lighting.** Principles of illumination. Manufacture and use of incandescent and arc lamps. Principles of meters with methods of use and systems. An elective course to any class of senior electrical students that may desire such special work. Prerequisite, E. E. 6. Lectures. II.; Th., 2; (1).

11. *Hydroelectric Power Plants. Water supply for power development; economic hydrology; location of plant; selection, subdivision into units, and arrangement of installation of machinery and accessories. Prerequisites, C. E. 12, Mechanics 3. Lectures, reports and designs. II., first nine weeks; M., Fr., 1, 2, 3; Director Aldrich.

16. Seminar. Study and discussion of current articles and reports by leading engineers and writers on engineering subjects; consideration of special topics of importance not included in the regular courses. I. and II.; arrange tim e;(1).

21. Electrical Engineering Laboratory. Study of the methods and the experimental determination of resistance, inductance, capacity, conductivity, electromotive force, current strengths, the magnetic properties of iron and steel, and voltmeter and ammeter calibration. Prerequisites, Physics 22. I.; Th., 5, 6, 7; (1).

22. Electrical Engineering Laboratory. Methods of testing and an experimental study of the characteristics and properties of direct-current generators and motors. Prerequisites, E. E. 1, 21. II.; M., 5, 6, 7; (1).

23. Electrical Engineering Laboratory. Experimental study of alternating-current generators and motors and transformers, their efficiency, regulation, etc. Prerequisites, E. E. 6, 22. I.; F., 5, 6, 7; (1).

24. Photometric Laboratory. Experimental study by photometric methods of intensity and distribution of light, from electric lamps, arc, and incandescent. Effect of shades on intensity and distribution. Life and efficiency tests. Prerequisite, E. E. 21. I.; F., 5, 6, 7; (1).

25. *Special Electrical Engineering Laboratory. Additional work in any of the above lines or in some entirely different line, as may be elected and satisfactorily arranged at the time. Prerequisites, E. E. 4, 22. II. (1 to 5).

31. *Electrical Design. Application of the theory of direct and alternating currents to the design of electrical apparatus. Prerequisites, E. E. 2, 6. Lectures and drafting. II.; (1 or 2).

ENGLISH.

Professor Michel.

The Faculty has adopted the following regulation concerning English work: "Students' papers of all kinds shall be scrutinized for English, and no student markedly deficient in English shall be granted a degree." Students are trained to express their ideas in clear, forcible language adapted to professional needs. Great stress is laid upon the correction of errors in the student's own writing, development of style being sought largely by means of individual criticism.

1. English. Theme writing with especial attention to descriptive and narrative composition, together with constant attention to the correct use of English in every day speech. All written work is returned and made the basis of individual criticism. I.; M., 4; W., 2; (2).

2. English. The work of the first semester continued, together with practice in the construction of the essay, from the gathering of the material to the finished product. The second part of the semester will be more or less devoted to Science of Rhetoric. During the sem-

ester the class will also read and discuss some one classic, both from the standpoint of style and from that of thought. Prerequisite, English 1. II.; M., 4; W., 2; (2).

3. ***English Literature.** Students in whose course it is not otherwise required may elect one or two semester hours of work in English Literature. I. and II.; (1) or (2).

HISTORY AND PHILOSOPHY.

Professor Michel.

1. ***Modern History and Current Topics.** This course is chiefly devoted to the serious study and aggressive discussion of vital questions—social, economic and political—so as to keep in touch with present movements. No textbook is used, but standard magazine and newspaper articles, important news of the week and the month, and news that bear upon the progress of the world are made the basis for study, investigation and discussion. I. and II.; (2).

2. ***History and Philosophy.** The chief aim of this course will consist in tracing our modern doctrines and thoughts to their sources by investigating old and modern philosophic doctrines with regard to psychology, ethics, cosmology, theology, metaphysics, biology, anthropology, political government and moral science (practical philosophy), scientific doctrines, etc. The work will be based on "Turner's History of Philosophy" with parallel readings, comparisons, study and discussion of extracts selected from standard works and essays. I. and II.; (1) or (2).

MATHEMATICS.

Professor McLeod.

The instruction in this department is designed, primarily, to meet the needs of engineering students. Particular attention is given to the practical applications to surveying, physics and engineering. These subjects are presented with such rigor of treatment, however, that the work done will serve as a sufficient foundation for the continuation of the study of applied mathematics.

2. **Trigonometry.** Measurement of angles; trigonometric functions of angles; relations between the functions of one angle and relations between the functions of several angles; trigonometric equations; methods of solution of oblique plane triangles and practical application thereof. Spherical triangles, their solution and practical application. Prerequisites, solid geometry and advanced algebra. I.; M., T., Th., F., 2; (4).

4. **Analytic Geometry.** Co-ordinates, the straight line, change of axes, anharmonic ratios, involution, the circle, the parabola, the ellipse, the hyperbola, polar equation of a conic. Prerequisite, Math. 2. II.; M., T., 2; (2).

5. **Calculus.** The study of the calculus, begun in Math. 12, is here continued. Successive differentiation, indeterminate forms, maxima and minima and functions of a single variable, expansion of functions, functions of two or more variables, applications to geometry, including curve tracing. Integration of rational and irrational frac-

tions, trigonometric and exponential functions; multiple integrals; mean values; approximate integration; integration by means or series, and the measurements of areas; integral curves. Prerequisites, Math. 4 and 12. I.; W., Th., F., 1; (3).

8. **Method of Least Squares.** This subject is given in connection with geodesy.

12. **Calculus.** Fundamental principles, differentiation of the elementary forms, successive differentiation, expansion of functions, rates and differentials, partial differentiation, tangents and normals; derivation of an arc, area, volume and surface of revolution, general principles of integration; integration as a summation; geometric applications; successive integration. Prerequisite, Math. 2. II.; Th., F., 2; (2).

13. **Analytic Geometry.** A continuation of Math. 4. Systems of conics, higher plane curves, envelopes and miscellaneous propositions. Co-ordinates, the plane, surfaces of the second degree, conicoids; surfaces in general. Prerequisite, Math. 12. I.; M., T., 1; (2).

MECHANICAL ENGINEERING.

Professor Swift.

1. **Kinematics.** Laws of motion; combinations of pure mechanism; toothed and belt gearing; forms of teeth of wheels; rolling and sliding contact; link work. Prerequisites, Drawing 33, M. E. 11. Lectures, recitations and drawing. I.; (1).

2. **Valve Gears.** General theory of slide valve and link motions, with practical application to designing valve mechanisms; the application of the Zeuner diagram to the principal automatic and radial gears and to the slide valve. Prerequisite, M. E. 1. Lectures, recitations and drawing. II.; (1).

6. ***Heating and Ventilation.** The general principles underlying the design of the various systems of heating and ventilation in common use; loss of heat from buildings and the heat given off from radiating surfaces; problems in proportioning ventilating ducts, etc.; mechanical details of different systems. Lectures and recitations. Arrange time.

7. **Gas Engines.** A study of internal combustion motors; historical development; construction of modern engines; theory of combustion; fuels, liquid and gaseous, and their adaptation to use in gas engines; gas producers; cycles and phases, and efficiency of cycles; properties of explosive mixtures; ignition, governing, carburization, carburetors and cylinder cooling; mechanical design of parts. Prerequisite, M. E. 13. I. and II.; (1).

8. **Elements of Engineering Construction.** Description and general principles of engines and boilers; the use and reasons for using various machines and parts of machines; details of cylinders, engine valves, etc.; the description and use of unions, valves, gages, pipe fittings and other elements of engineering construction; practice in the use of an engineering vocabulary; course is supplemented by freehand sketches of various parts of engines, etc. Lectures and recitations. II.; T., Th., 3, 4; (2).

11. **Elements of Mechanism.** A study of theoretical mechanism; an examination into the various contrivances and arrangements of

parts in machinery whereby motion is set up and modified; the transmission of force by the same. Prerequisite, M. E. 8. Lectures and recitations. II.; M., F., 4; (2).

13. **Heat Engines.** A study of the theory and mechanism of all forms of heat engines; steam engines, reciprocating, rotary and turbines; steam boilers and accessories; internal combustion motors; air and vapor engines; air compressors, refrigerating machinery. Technical thermodynamics and practice in the use of the Entropy-Temperature method of analysis. Lectures, conferences and problems; also, visits to shops, factories and power stations. Prerequisites, Physics 2, Mechanics 5. I.; (4); and II.; (2).

14. **Kinematics.** An advanced course for seniors in Mechanical engineering, including a mathematical study of various forms of dynamometers, planimeters, engine governors, and fly wheels; and a graphical study of the forces acting in the reciprocating engine. Prerequisites, M. E. 1, Mechanics 4. I.; arrange time; (2).

15. **Steam Turbines.** A study of the principles involved in the design of the steam turbine; e. g., the flow of steam through nozzles and blade channels; the choice of peripheral velocities, angles and steam velocities; work lost in friction, etc.; a discussion of the construction of the most important parts; the regulation; the adaptation of the steam turbine to the various purposes, as power plant practice. Prerequisite, M. E. 13. I.; F., 2; (1).

16. **Conference.** Discussion of current engineering topics and technical literature. II.; (1).

20. **Experimental Mechanics.** Methods of measuring power; determination of power used by different machines; losses of power in transmission; determination of belt friction; the use of planimeters, slide-rules, etc. Experiments on tensile strength of iron, steel and other constructive materials; compression strength of cast iron, and of timber; transverse tests of steel and wooden beams and cast-iron bars; torsional tests of steel and iron shafting; a course to accompany Mechanics 2 and 4, and Chemistry 24. I. and II.; (1).

21. **Advanced Testing Materials.** Special mechanical and physical tests of bronzes, alloys and anti-friction metals, including micrographic examinations and study of structure; methods of steel reinforcement of structural concrete work; road materials and properties, and comparative tests for valuation and efficiency; assignment of individual problems and projects for investigation, tests and reports. Prerequisite, M. E. 20, Mechanics 2. II.; (1).

23. **Mechanical Engineering Laboratory.** Tests of steam engines. condensers and boilers; indicator and brake methods of measuring power; standardization of apparatus. Tests of engines and complete power plants in the vicinity. Efficiency tests of steam and air pumps, injectors, ejectors, gas engines, ventilating apparatus; radiation and pipe covering tests; steam flow; hydraulic measurements; tests of lubricants, etc. Prerequisite, M. E. 20. I. and II.; S., 1, 2, 3; (1).

31. **Gas Power Plants.** Choice of source of motive powers for given project; economics of gas power development, management and operation; apparatus and machinery in use in modern gas power plants gas producers and accessories, scrubbers, cleaners, vaporizers, etc.; fuels and processes; design, specification, bill of material, tracings and blue prints for project. Prerequisite, M. E. 7. II.; (1).

32. Steam Power Plants. Steam Power Plant design. This includes the choice of type, size, and number of boilers to be used, a study of the attendant auxiliary apparatus, such as boiler feed pumps, coal handling devices and the like. Choice of engines or turbines to be used, with necessary piping, and a study of condensers and air pumps. Prerequisites, M. E. 13, 23. II.; arrange time; (2) or (3).

MECHANICS.

1. Theoretical Mechanics. Statics of material points, rigid bodies, flexible cords; centre of gravity; rectilinear, curvilinear motion; moment of inertia; dynamics of rigid bodies, work, energy, power and friction. Applications to engineering problems. Prerequisites, Mechanics 5, Physics 1. Lectures, recitations and problems. II.; last nine weeks; M., T., W., Th., F., 2; (2½). Professor Swift.

2. Applied Mechanics. Elementary stresses and strains, principles, laws and factors; theory of flexure and applications in engineering construction; analytical and graphical methods; materials of engineering. Prerequisite, Mechanics 1. Accompanied by laboratory work in testing materials. M. E. 20. Lectures, recitations and problems. I.; M., T., W., 1; (3). Director Aldrich.

3. Hydraulics. Hydrostatics and theoretical hydraulics; study of flow through orifices, tubes, pipes, over weirs, in conduits, canals and rivers; applications in engineering, water power plants and developments. Prerequisite, Mechanics 1. Lectures, recitations and problems. II.; M., W., F., 1; (3). Professor McLeod.

4. Theoretical Mechanics. A continuation of Mechanics 1, accompanied by course in experimental mechanics and power measurements. M. E. 20. I.; Th., 1; (1). Professor Swift.

5. Differential Equations. Formation of a differential equation; equation of the first order; singular solutions; linear and exact differential equations; equations of particular forms; integration in series; equations of the second order; equations involving more than two variables; partial differential equations; special forms of differential equations; applications to geometry, mechanics and physics. Prerequisite, Mathematics 5. Text, Murray. II.; first nine weeks; M., T., W., Th., F., 2; (2½). Professor Swift.

MINING.

3. Mineralogy. Crystallography, occurrence, chemical and physical properties, and means of detection of the principal minerals including the native elements, sulfids, chlorids, fluorids, oxids, carbonates, silicates, phosphates. Especial attention is paid to minerals and ores of commercial value. Prerequisite, Chemistry 2. Recitations and laboratory. II.; W., Th., 3; Tu., 5, 6, 7; (3). Professor Williams.

4. Mining. Methods of mining, hoisting, pumping, ventilation, illumination, hygienic conditions, shafts, sinking in running ground, timbering, boring, breaking ground, blasting, drills and drilling, the compression of air, and mine examination. Prerequisite, Chemistry 4, Mechanics 2. Lectures and recitations. I.;T., Th., 5. (2). Professor McLeod.

5. Metallurgy of Iron and Steel. Study of the types and geographical distribution of the various iron ores of the United States, specifications for and grading of ores, with current market prices of same; construction and operation of the blast furnace, grading of pig iron and valuation from market quotations, manufacture of wrought iron and steel, Bessemer and open hearth, acid and basic; constituents and manipulation of self-hardened tool steels. Lectures and assigned papers. II.; M., 3; (1). Professor Williams.

26. Assaying. Practice in methods of both wet and dry assays of ores of commercial importance such as gold, silver, copper, lead, zinc, etc. Prerequisite, Chemistry 4. Laboratory courses. II.; Th., 5, 6, 7; (1). Professor Williams.

MODERN LANGUAGES.

Professor Michel.

In these courses no attention is given to composition. The purpose is to enable the student to avail himself of French and German works relating to his profession, and to give him the ability to read these languages with such ease that it will be a source of pleasure and usefulness to him throughout life. Especial attention is given to readings in pure and applied science, while short works of the best authors are also read. However, the classes will be so conducted as to enable the student to carry on every day conversation. Every opportunity is sought to arouse an interest in the life of the French and German peoples.

Students who upon entering offer one or two years' creditable academic work, in either language, may be exempt from one or two semesters' language work, respectively; the time to be devoted to technical or other work, chosen from the regular, or elective courses offered in this Institution.

1. French. Fraser and Squair's grammar; fairly easy texts of modern French prose, sight reading and translation at hearing. I.; M., W., F., 3; S., 1; (5).

2. French. Scientific French Readers, one or two modern French dramas or stories, current scientific periodicals; sight reading of fairly difficult Modern French prose. Prerequisite, French 1. II.; M., T., W., Th., F., 1; (5).

3. *French. A continuation of the method of study followed in French 2. Prerequisites, French 1 and 2. I.; M., Th., 2; (2).

1. German. Kayser and Monteser's Brief German Course; easy texts of modern German prose, sight reading and translation at hearing. I.; M., T., W., Th., F., 1; (5).

2. German. Scientific German Readers, one or two modern dramas or stories; scientific periodicals; sight reading of fairly difficult German. Prerequisite, German 1. II.; M., W., F., 3; S., 1; (5).

3. *German. A continuation of the method of study followed in German 2. Prerequisites, German 1 and 2. I.; T., F., 2; (2).

***Modern Language Electives.** Students who have the necessary preparation may, in the junior and senior years, elect one or two semester hours of French or German technical reading. This work will be individual, each student being expected to read along the line of his special course. Spanish may also be offered as an elective.

PHYSICS.

Professor Brackett.

1. Physics. Disigned to lay a foundation for the student's future work in the various branches of engineering. Much attention is given to correct and exact conceptions of the various phenomena studied and to a clear understanding of the units employed in measurements and in computations. The mathematical treatment of physical questions and the intelligent solution of examples are made fundamentally important. Subjects for first semester, Mechanics and Heat. Prerequisite, Mathematics 12. I.; M., T., W., Th., F., 3; (5).

2. Physics. A continuation of Physics 1. Sound, Light and Electricity. Prerequisite, Physics 1. Lectures and recitations. II.; M., T., W., Th., F., 3; (5).

4. Physical Chemistry. A course in the mathematical theory of physical chemistry, treating the subject from the standpoint of energy transformations and employing the methods of the calculus. Lectures and problems. I.; T., Th., 2; (2).

21. Physical Laboratory. A course to illustrate the more important physical laws. The work is quantitative in its nature and includes the use of physical measuring instruments, methods of determining physical constants and experimental work in Mechanics and Heat. Much attention is given to sources of error, and the estimation of the probable accuracy of results. Prerequisite, Mathematics 12. I.; M., or T., 5, 6, 7; (1).

22. Physical Laboratory. A continuation of Course 21, and including work in Sound, Electricity, Magnetism and Optics. Prerequisites, Physics 1 and 21. II.; M., or T., 5, 6, 7; (1).

SHOPWORK.

Professor Graffam.

3. Woodworking. Bench work in wood; sawing, planing, gauging, chiseling, boring, mortising, dovetailing, fitting and joinery; construction, care and use of tools; structure and use of woods, principles of seasoning and influences affecting their growth. Lectures and practice. I.; M., or Th., 5, 6, 7; (1).

4. Forging. Care of forge fire; heating, drawing out, bending, upsetting, heading, swaging, welding, hardening, tempering and annealing; tool making and dressing; properties of iron and steel, effects of mechanical and heat treatment. Lectures and practice. I.; W., 5, 6, 7; S., 2, 3, 4; (2).

6. Wood-Turning. Various exercises in turning on centres and with screw centres; face-plate, chuck work and ornamental turning. Prerequisite, Shopwork 3. II.; T., 5, 6, 7; (1).

7. Pattern-Making. Patterns and core boxes for moulding simple structural and machine elements; two and three-part flask work. Prerequisite, Shopwork 6. II.; Th., 2, 3, 4; (1).

9. Foundry. Moulding from patterns made by the students and from such other patterns as are necessary to illustrate the principles of foundry practice; mixing and tempering, moulding and sore sands; making and baking cores; preparing castings for the machine shop. II.; T., 2, 3, 4; (1).

10. **Elementary Machine Work.** Bench work in iron; chipping, filing, fitting, scraping, polishing; formation of straight edges, surface plates, gauges, etc.; machine tool work with drill press, lathe, shaper, planer and drill grinder, production of small tools for the machine shop. Prerequisite, Shopwork 4. II.; M., W., or F., 5, 6, 7; S., 2, 3, 4; (2).

12. **Mechanical Construction.** Work from students' designs and drawings; manufacture of special apparatus for shop and laboratory use; design and construction of modern machine tools, motive-power machinery and accessories. Prerequisite, Shopwork 10.;Lectures and practice. I.; T., Th., 1, 2, 3, T., 5, 6, 7; (3).

LIST OF STUDENTS—1906-1907.

ENGINEERING COURSES.

Abbreviations: C. E., Civil Engineering; E. E., Electrical Engineering; M. E., Mechanical Engineering.

Seniors.

Craig, Leon Charles... ... .C. E.............St. Lawrence.
Dullea, Maurice Francis ... ...C. E.............Brasher Falls.
Finch, Floyd Ray... ... ...E. E.............Livingston Manor.
Gleason, Claude Franz... ... .C. E.............Caneadia.
Hawley, Jean Hodgkins... ....C. E.............Colton.
Huntington, Robert Charles.. ..E. E.............Malone.
Meacham, Archibald Chas. Wm. C. E.............St. Regis Falls.
Owen, Charles Duane... ... ..E. E.............Manlius.
Thomson, David Dittmar... ...C. E.............Watertown.
Wellington, Ivan Roy... ... ..C. E.............Canton.
(A.B., St. Lawrence University, 1901)
Wiswell, Ray Duane... ... ...C. E.............Potsdam.

Juniors.

Grieb, John Jacob... ... .M. E.............Brier Hill.
Hall, Roy Frank... ... ...C. E.............Clayton.
Hardenburgh, Joseph Rock.. ..E. E.............Roscoe.
Hinds, Charles Leo.... ... ...M. E.............Malone.
Lynch, Jerry Paul... ... .C. E.............Stockholm Center.
Merriman, Charles Stephen... .E. E.............Black River.
Moulton, Karl... ... ...C. E.............Cuba.
Roulston, Harvey R.... ... ...C. E.............Heuvelton.
Rutherford, Lewis. ... ...E. E.............Waddington.
Safford, Rufus Lasher... ... ..C. E.............Glens Falls.
Schrodt, John Philip... ... ...E. E.............Black River.
Sprague, Hugh Max... ... .C. E.............Potsdam.
Tracy, Grant... ... ...E. E.............Andover.

Sophomores. (Matriculated).

Biche, Adrian James... ... ...Black River.
Dailey, Frederick Irving... ... ...Clayton.
Eastman, George Lockwood... ....Potsdam.
Gorman, Laurence Joseph... ... .Madrid.
Mayhew, Valier... ... ...Watertown.
Morse, Bryan Woodward... ... .Washington, D. C.

McCullough, Lee William... ... .Millers Falls, Mass.
McNulty, John... ... ...Potsdam.
Rodger, George McGregor... ....Hammond.
Rushton, Sidney Pflaum ... ...Canton.
Scofield, Hervey Noble... ... ...Mohawk.
Strough, Roscoe Perrin... ... .Potsdam.
VanHorne, Theodore... ... ...Cooperstown.
Welker, Loy Ellsworth... ... ...Oil City, Pa.
Welker, George Ernest... ... .Oil City, Pa.

Freshmen.

(Matriculated and Candidates for Matriculation.)

Abbott, George Henry... ... ...Loon Lake.
Baker, Gardner Carver... ... ...Machias.
Boland, Francis Herbert... ... .Canton.
Burrows, Grover Cleveland... ... .Hermon.
Clark, Earl Jedidiah... ... ...Parishville.
Corwin, Harold Gray... ... ...Southampton.
Croissant, Frederick James... ... .Antwerp.
Davis, Walter Strough... ... ...Little Falls.
Echeverria, Carlos Porfirio... ... .Mexico City, Mex.
Griffin, Allan Austin... ... ...Oswegatchie.
Heckles, John Charles Olmstead... ....Canton.
Heissler, Louis John... ... .Canajoharie.
Jervis, Charles Miller... ... ...Copiague, L. I.
Jones, Harry Russell... ... ...Adams.
Kelley, Roy Lee... ... ...Gouverneur.
MaGuire, Charles Henry... ... .Ogdensburg.
Merithew, Jerry Jay... ... ...Hermon.
Merrill, Albert Darius... ... ...North Lawrence.
Merriman, Harvey Merle... ... .Black River.
Morgan, James Henry... ... ...Norwood.
Newton, James Reginald. ... ...Watertown.
O'Malley, Conrad Vincent... ... .Potsdam.
Percival, Donald Willmore... ... .Portville.
Sisson, Lewis Hamilton... ... ...Potsdam.
Stevens, Harold Jehiel ... ...Brasher Falls.
Van Horne, Grenville White... ... .Cooperstown.
Weed, Lloyd Woolsey... ... ...Potsdam.
Willson, Laurence Huntington ... .Malone.

Specials.

Candidates for Matriculation.)

Burch, Byron Fred... ... ...Potsdam.
Young, John Alfred... ... ...Potsdam.

HOME ECONOMICS.

Two Year Certificate Courses.

Second Year.

Danforth, Lena Elizabeth... ... .Massena.
Fulton, Lucy... ... ...Carthage.
Mott, Stella Celestia... ... ...Piercefield.
McCarthy, Anna Elizabeth... ... .Norwood.
Rickett, Lelia Wenonah... ... .Heuvelton.
Signor, Katharine Agnes ... ...Ridgway, Pa.

First Year.

Burns, Edna Catharine... ... ...Potsdam.
Hepburn, Mayfred... ... ...Colton.
Lynde, Manie Agnes... ... ...Natural Bridge.
Pohl, Edith Louise... ... ...Watertown.
Wagner, Bertha May... ... ...Redwood.

SUMMARY OF STUDENTS, 1906-1907.

Engineering Courses:

Seniors	11
Juniors	13
Sophomores	15
Freshmen	28
Specials	2
Total	69

Home Economics. (Certificate Course).

Second Year	6
First Year	5
Total	11
Total in the School	80

DEGREES AND CERTIFICATES.

Degrees Conferred, Certificates Awarded and Subjects of Theses Presented for Graduation, Seventh Annual Commencement, June 15, 1906.

Degrees.

Bachelors of Science in Civil Engineering.

Carl Christian Ahles, ...Redwood, N. Y.
Frank Heath Flint, ...Parishville, N. Y.
Joint Thesis: Discharge of Racquette River at Potsdam, N. Y.

Roger Dean Flint, ...Potsdam, N. Y.
Thesis: Plan and Design of a Hydro-electric Power Plant at Colton Falls, N. Y.

Abel Farrington Simpson, ...Potsdam, N. Y.
Thesis: Design and Proposed Layout for Railroad Station and Yard Facilities, at Potsdam, N. Y.

Bachelors of Science in Electrical Engineering.

Robert Jay Burrows, ...Youngstown, Ohio.
Thesis: Experimental Determination of Permeability at Low Densities.

Francis Patrick Cummings,.. .. .. Raymondville, N. Y.
Ralph Burton Leonard, ...Malone, N. Y.
Joint Thesis:..A Study of the Operation of the Hannawa-Ogdensburg Transmission Line.

Arthur Bender McIntyre, ...Webster, N. Y.
Thesis: Comparative Study of Design and Construction of Long Distance Transmission Lines.

Francis Long Perkins, ...Potsdam, N. Y.
Howard Sanford Phelps, ...Moravia, N. Y.
Joint Thesis: An Experimental Study of the Effects on Interruptions upon the Action of Induction Coils.

Bachelor of Science in Mechanical Engineering.

Ceylon Roy Cady, ...Brushton, N. Y.
Thesis: The Testing of High Speed Gasoline Motors.

Bachelors of Science in Home Economics.

Irma Hale (B.S., 1903; A.M., 1906, St. Lawrence Univ.) Canton, N. Y.
Thesis: A Study of Bacteria in Relation to Home Economics.

Mildred Mae Parker, ...Morrisville, N. Y.
Thesis: Food Adulteration.

Certificates.

For Two Year Course in Home Economics.

Sarah Edna Bush, ... Canajoharie, N. Y.
Thesis: Domestic Science in the Rural Schools.

Corinne Marietta Frame, ...Clayton, N. Y.
Thesis: Common Household Insects and their Extermination.

Ruth Mabel Hungerford, ...Evan's Mills, N. Y.
Thesis: A Dietary Study Conducted in Potsdam.

LEVINUS CLARKSON SCHOLARSHIP,

Annual award announced on Founder's Day, November 30.
1906-1907.

Bryan Woodward Morse, '09, ...Washington, D. C.

ALUMNI.

Clarkson Tech. Alumni Association.

Officers for 1906-1907.

Charles A. Pohl, '02, President, ...Lyons, N. Y.
Burton L. Delack, '03, Vice-President, ...Schenectady, N. Y.
F. Casper Zapf, '04, Secretary, ...Schenectady, N. Y.
Lloyd W. Greene, '05, Treasurer, ...Watertown, N. Y.

(An Employment or Co-operative Bureau for Clarkson Tech graduates is maintained by the Alumni Association. Secretary for 1906-1907, F. Casper Zapf, 240 McClellan St., Schenectady, N. Y.

1900.

Robert H. Fenn, B.S. in Mechanical Engineering, Mechanical Engineer, Kent Mill Company, 170 Broadway, New York;mail Suffern, N. Y.

Julius R. Jacobson, B.S. in Electrical Engineering, General Electric Company; mail, Construction Department, General Electric Schenectady, N. Y.

Charles H. Lawrance, B.S. in Electrical Engineering, Instructor in Drawing and Mechanics, College of Agriculture and Mechanic Arts, West Raleigh, N. C.

Carlton E. Smith, B.S. in Electrical Engineering, Thompson Starrett Company, 51 Wall St., New York.

1901.

Robert T. Danforth, B.S. in Electrical Engineering, Aluminum Company of America, Massena, N. Y.

John E. Harriman, B.S. in Electrical Engineering, Home Telephone Company; mail 511 Olive St., Kansas City, Mo.

Norman L. Rea, B.S. in Electrical Engineering, Assistant Superintendent, General Electric Company; mail, 107 Lafayette St., Schenectady, N. Y.

George A. Stebbins, B.S. in Electrical Engineering, Secretary Stebbins Engineering and Manufacturing Co., 74-78 Smith Building; mail, 36 Keyes Ave., Watertown, N. Y.

Sidney L. Wailes, B.S. in Electrical Engineering, Manager of Sales, National Brake and Electric Company, 519 First National Bank Building, Chicago, Ill.

William H. Wilcox, B.S. in Civil Engineering, Lowville and Beaver River R. R. Co., Lowville, N. Y.

1902.

Walter N. Brand, B.S. in Mechanical Engineering, Assistant Mechanical Engineer, Smith Premier Typewriter Company; mail, 519 Park Ave., Syracuse, N. Y.

William G. Evans, B.S. in Civil Engineering, Assistant Engineer, South Park Commission, 57th St. and Cottage Grove Ave.; mail 4952 Forrestville Ave., Chicago, Ill.

William J. Fox, B.S. in Electrical Engineering, Westinghouse Electric and Manufacturing Company, 902 University Block; mail, 319 West Geneseee St., Syracuse, N. Y.

Rea M. Gordon, B.S. in Mechanical Engineering, Assistant Engineer of Tests, Solvay Process Co.; mail 319 W. Genesee St., Syracuse, N. Y.

Harry F. Halladay, B.S. in Mechanical Engineering, Depauville, N. Y.

Joel M. Howard, B.S. in Mechanical Engineering, Assistant Engineer, Sicilian Asphalt Paving Company, Times Building; mail, 273 W. 140th St. New York, N. Y.

Sanford C. Humphrey, B.S. in Electrical Engineering, Carthage, N. Y.

Otis C. Loomis, B.S. in Mechanical Engineering, Engineer and Superintendant, D. F. O'Rourke, Contractor; mail, 414 Pine Ave., Altoona, Pa.

Wait R. Loveless, B.S. in Civil Engineering, Constructing Engineer, Illinois Steel Co.; mail, 8950 Exchange Ave., Chicago, Ill.

Charles A. Pohl, B.S. in Civil Engineering, Assistant Engineer, New York State Barge Canal, Lyons, N. Y.

Charles B. Richardson, B.S. in Electrical Engineering, Electrical Engineer, Wagner Electric Manufacturing Co., 1625 Marquette Building, Chicago, Ill.

George J. Stanley, B. S. in Electrical Engineering, Aluminum Company of America; mail, Poqueto Club, Parnassus, Pa.

Carlton E. Ward, B.S. in Civil Engineering, St. Louis & Mineapolis R. R.; mail, 1141 Metropolitan Life Building, Minneapolis, Minn.

1903.

Benjamin F. Batchelder, B.S. in Civil Enginering, with Williams, Procter & Potts, Sanitary Engineers, 1702 Whitehall Bld., New York City; mail, Ravenna, Ohio.

J.Everett Beswick, B.S. in Civil Engineering, Rapid Transit Railroad Commission, Division Engineer's Office, 4 Court Square, Brooklyn; mail, 123 E. 18th St., New York City.

Burton L. Delack, B.S. in Electrical Engineering, Railway Engineering Department, General Electric Co.; mail, 429 McClellan St., Schenectady, N. Y.

George O. Hodge, B.S. in Mechanical Engineering, New York Car and Truck Co., Kingston, N. Y.

Frederick M. Lehr, B.S. in Electrical Engineering, Stone Mills, N. Y.

George G. Sweet, (A.B., Cornell University, 1901) B.S. in Civil Engineering, New York State Barge Canal Office, DeGraff Building; mail, 68 Phillip St., Albany, N. Y.

1904.

Samuel F. Carlisle, B.S. in Civil Engineering, New York State Barge Canal; mail, 20 S. Hawk St., Albany, N. Y.

Charles A. Gridley, B.S. in Civil Engineering, Pennsylvania Railroad, Tunnel Division, Jersey City, N. J.

Ralph D. Hayes, B.S. in Civil Engineering, New York State Engineer Department; mail, Middletown, N. Y.

Frank C. Zapf, B.S. in Chemical Engineering, Chemist, General Electric Co.; mail, 240 McClellan St., Schenectady, N. Y.

1905.

Harry B. Claflin, B.S. in Electrical Engineering, Superintendent of Construction, Pittsburg Display Advertising Co., 321 Lewis Building, Pittsburgh Pa.

Clinton A. Curtis, B.S. in Civil Engineering, New York State Barge Canal, Fort Edward, N. Y.

Harold S. Dunsford, B.S. in Electrical Engineering, Turbine Department, General Electric Co.; mail, 301 Germania Ave. Schenectady, N. Y.

Lloyd W. Greene, B.S. in Civil Engineering, R. W. & O. Division, New York Central Railroad Co.;mail, 23 Burchard St., Watertown, N. Y.

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School of Technology
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The object of the Clarkson foundation is to provide technological education of college grade.

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ELECTRICAL ENGINEERING LABORATORY.

Junior Course.

By Byron B. Brackett, A.M., Ph.D.*

In the Physics Laboratory course, of the preceding year, there have been included exercises in the study of various types of galvanometers. Some actual measurements involving the use of sensitive galvanometers have also been made. A few of the experiments listed in this junior course have been performed in the work of the Sophomore year, but in every instance with less delicate apparatus and with less accuracy and refinement of manipulation.

Experiment 1. Resistance by the Differential Galvanometer Method. Balance the effects of the same current, in front and back coils, to give no deflection, or a very small one. Branch the circuit, to the front and back coils, with the known resistance in one branch and the unknown in the other branch; adjust for no deflection; then reverse the position of the known and unknown resistances; and readjust for no deflection, if needed. Test sensibility or number of ohms that must be changed to make galvanometer show deflection, first one way and then the other.

Experiment 2. Comparison of the E. M. F. of Cells, by means of a high resistance and a sensitive current galvanometer. Set up and focus the reading telescope. Adjust a pencil mark resistance on ground glass to make the deflection large enough to be read with accuracy. Explain the advantage of high resistance in the circuit of a voltage measuring instrument, and how the apparatus used could be made into a voltmeter.

Experiment 3. Compare E. M. F. of Cells, by means of a ballistic galvanometer and condenser. Observe the need of some damping device, to use after the throw has been made.. State relative advantages and disadvantages of this method and that of Experiment 2.

Experiment 4. Resistance by means of the Slide-wire Bridge. Balance, so that one millimeter movement of contact point on the wire gives deflections in opposite directions. Reverse positions of unknown and known resistances. Exchange battery and galvanometer connections. Average the results of the four tests. Explain what might cause different results in the four cases.

Experiment 5. Resistance by means of the Wheatstone Box-Bridge. Measure several resistances with different ratio arms. Observe change of resistance in the bridge rheostat needed to change direction of galvanometer deflection, in each case. Tabulate and show best value of arms to use with each resistance determined. Study several types of box bridges, and show by diagrams how to connect each for use.

Experiment 6. To Find Constant of a very Sensitive Galvanometer for Steady Current. Make several determinations from deflections at different points on the scale. State sensibility in terms of ohms (or megohms), current, and potential difference at the terminals. Com-

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pute resistance in series required to make the galvanometer a direct-reading voltmeter, and the resistance in parallel that would make it a direct-reading ammeter.

Experiment 7. To find Constant of a Ballistic Galvanometer, for Quantity of Electricity Discharged through it. Study an adjustable condenser, and its capacity for various positions of its plugs. Compute the charge that the condenser will take from the cell to be used, with several arrangements of the plugs. Discharge various quantities through the galvanometer to give throws to several well distributed points on the scale. Compute quantity per division of the scale from each, and plot a deflection-quantity curve.

Experiment 8. Comparison of Capacities, by means of the Ballistic Throws. Connect so that the two condensers may be alternately charged from the same cell, and discharged through the galvanometers by means of the keys alone. Study the effects of long and short charges, and electrical absorption in the condensers. Ascertain precautions that are necessary in order to use this method when the condensers compared are not of the same construction.

Experiment 9. Damping of Ballistic Galvanometers, and its effects on results. Determine the logarithmic decrement of a galvanometer and compare: (1 plus ½ L)elongation, with elongation plus ¼ (1st elongation—2nd elongation). State causes of damping and circumstances that may increase the amount of damping, especially in d'Arsonal galvanometers. Explain how readings taken with the same ballistic galvanometer, with different damping effects, may be corrected to compare with each other.

Experiment 10. To find the Constant of a Ballistic Galvanometer, for quantity by the absolute method. Compute the constant from the sensibility for current, the time of oscillation, and the logarithmic decrement. Verify the result by using a standard condenser and cell, to find the constant, as in Experiment 7.

Experiment 11. To find Constant of a Ballistic Galvanometer for Quantity, by means of a standard solenoid. Use various currents to give both small and large deflections. Observe whether the closed circuit of the secondary of the solenoid will affect this constant. If the constant is modified by this circuit, explain how to correct from this to the open circuit condition: also how to calibrate this galvanometer for lines of magnetic induction.

Experiment 12. Magnetization Tests, by the Permeameter Method. From the tractive pulls produced, compute the magnetization caused by various increasing currents, and plot the results in an H. and B curve.

Experiment 13. Magnetization and Permeability, by means of the ballistic galvanometer. Use the Rowland reversal method, on a ring shaped specimen. Plot both magnetization and permeability curves.

Experiment 14. Hysteresis by the Ballistic Galvanometer. Use the step-by-step method, on a ring specimen. Plot the hysteresis cycle Compute the energy represented by it, and estimate the approximate value of the hysteresis constant for the specimen.

Experiment 15. Coefficient of the Induction of a Coil, by comparison with a standard condenser. Use the bridge method, and as nearly as possible neutralize the kick from the coil by a standard adjustable condenser. Explain the peculiar difficulties of the method.

Experiment 16. Coefficient of Induction by the Absolute Method. Use Lord Rayleigh's bridge method, involving the time of swing of the galvanometer system, the logarithmic decrement, and the steady deflection caused by a slight unbalance of the bridge resistance.. Make three different tests with all resistances used varied as much as possible. Explain when the decrement might be different or the galvanometer even cease to act ballistically in one of these tests.

Experiment 17. Comparison of Coefficients of Inductance, by the Bridge Method. Connect two coils of fixed coefficients of inductance into a bridge, and balance for both steady current and reversal of the current. Explain difficulties, and formulate a method to secure the adjustments necessary with as little delay as possible.

Experiment 18... Comparison of Coefficients of Inductance, by means of the secohmmeter. Use a standard adjustable inductance, in one arm of a bridge, and an unknown inductance in another arm. Connect both battery and galvanometer circuits through the secohmmeter. Explain the advantages of both variable inductance standard and the secohmmeter. Suggest a simpler apparatus for the secohmmeter and galvanometer in approximate comparison of inductances.

Experiment 19. Study of a Lamp-Board Resistance. Examine system of connection and show by diagrams how to set the switches for series, parallel, and mixed arrangements of the units. Tabulate a large number of the possible arrangements, and the approximate resistances that each one would give. Note the change in resistance with temperature of the carbon filament, and the different effects of a lamp when arranged to glow or to remain dark.

Experiment 20. Examination of Voltmeters. Compute the currents taken at full scale reading by several representative instruments; also the current per volt. Observe that under certain conditions a voltmeter may be used to measure small currents. Explain how each instrument may be used to read voltages up to twice its scale limits, and also to five times its scale limit. State desirable characteristics for a voltmeter.

Experiment 21. Comparison of Voltmeter Readings. Take simultaneous readings on two voltmeters, connected to points of various potential differences. Secure readings throughout the ranges of instruments and plot as a curve. Assume one to be correct and explain probable cause of error in the readings of the other. Show by diagram how to connect ammeters for comparison and state what kind of resistances must be used.

Experiment 22. Calibration of Voltmeters and Ammeters. Compare with a standard milli-voltmeter. Use proper multipliers or suitable amounts of standard box-resistances for voltmeter comparisons; and suitable shunts for ammeter tests. Plot correction curves, and indicate region of uncertainty or possible reading error.

Experiment 23. Resistance by Means of the Voltmeter. Find apparent value of several resistances by this method. Estimate possible error due to slight inaccuracies in the readings. Deduce value of resistance that may be determined most accurately by means of a given voltmeter, and the limits through which it may be used with fair accuracy.

Experiment 24. Resistance by Means of Ammeter and Voltmeter. Measure large and small resistances. Ascertain kinds of instruments

required in each case, and errors possible from improper connections, or neglecting to consider the voltmeter current.

Experiment 25. Examination of the Electrical Circuits of Dynamos. Examine a group of typical dynamos and motors. From size of armature wire, ascertain how many paths the armature of each must have. Make an outline diagram of each machine and show all circuits in it.

Experiment 26. Study of Armature Windings. Examine the armatures of two or more typical machines. Make a diagram of the shape of a single coil of each with its end connections. Give pitch of coils and pitch of the commutator connections. Prepare full winding tables, and make diagrams of the windings.

Experiment 27. Magnetic Circuit of Dynamos. From armature windings, rated speed, and voltages, estimate flux. Then from measured dimensions of the machine compute density of magnetization in various portions of the magnetic circuit and estimate the ampere-turns required for each part.

Experiment 28. Measurement of the Magnetic Flux in a Dynamo. By means of a suitable ballistic galvanometer find flux in various parts of the magnetic circuit. Compute leakage coefficient.

Experiment 29. Examination of the Mechanical Condition of Dynamo or Motor. Observe bearings, how oiled, and if properly supplied. Examine commutator and brushes for their various adjustments. Examine all connections to see if placed in correct position and sufficiently secured.

Experiment 30. Operation of Dynamo. Connect a shunt dynamo that has been put out of electrical adjustment, to switch board, with field box, cut-out and switch. Make the machine excite, give normal voltage at regular speed with field box, adjusted to about half its resistance, and see that the voltage delivered responds properly to any change in the field box resistance.

Experiment 31. Magnetization Curve of a Shunt Dynamo. Excite field from an external source. Keep speed normal, and read terminal E. M. F., as field current is gradually increased and then decreased. Observe values of field current, and where the E. M. F. does not respond readily to small changes of field current. Explain conditions or relations other than field current that affect the terminal E. M. F., when the dynamo armature delivers a current.

Experiment 32. Terminal E. M. F. of Shunt Dynamo. Under varying load currents, keep speed constant, resistance of shunt field circuit unchanged. Read terminal voltage as the current taken from the machine is increased to and beyond the full load value. Measure armature resistance, deduct voltage drop due to that and explain the drop in addition to that caused by resistance.

Experiment 33. Connect and Operate a D. C. Shunt Motor. Select from a group of unlabeled starting boxes one suitable for the motor to be used. Show from resistance tests and current-carrying capacity, that the one selected is suitable. Select a field or speed-control box in the same way. Connect these to the motor with main switch and fuse blocks properly placed, but with no connection to the source of power till after the circuits arranged have been inspected and approved. Then connect to power mains and run motor.

Experiment 34. Speed Characteristics of Shunt Motor. Study and plot change of speed with variation of field current, position of

brushes, etc. Explain cause for the changes of speed observed.

Experiment 35. Brake Efficiency of a Motor. Absorb power from a small shunt motor by means of a strap (Prony) brake. Compute output and input and plot the efficiency curve. Enumerate the sources of all losses in the motor.

Experiment 36. Efficiency of a Motor by Electrical Method. By the stray power and electrical loss method, find power to run armature light. Measure resistance carefully. Then compute efficiency for various assumed currents. Plot results, compare with results of previous experiments, and explain any discrepancies. Explain how this method would be applied to a dynamo.

SHOP TRAINING FOR ENGINEERING STUDENTS.

By Wm. M. Towle, B.S.*

The engineer to be a skillful director of production should understand the methods of doing work, and this can be acquired only by actual contact with tools, machines, and material. Therefore, in any scheme for educating engineers, it is necessary to provide some method of giving this instruction and training. For the best results it is essential that the student should have an aptitude for this kind of work. This requirement combined with hard study, careful training, and a determination to master the details of the profession will bring success.

Alfred Mosely has said that "The American public schools develop an initiative and encourage imagination and the reasoning powers of the pupils." Their future shop training, whether for industrial or engineering pursuits, should continue and develop these qualities to a large degree.

In any consideration of this subject, in its relation to engineering education, we must remember that it is only one of several that the student takes up during the four years' course of study for the baccalaureate degree; and that but little time can be given to each of the different branches of shop work. It is certainly not probable that as much time will be given to it as the instructor may think desirable, for in every curriculum it must be a compromise with the Faculty as to the time that is to be apportioned to each department of instruction.

The shopwork should be taught for both its educational and its utilitarian value. It is not usually possible to ascertain just what line of work the young engineer will follow after graduation. It may be in the field of production, design, construction, operation, supervision, or he may become engaged in the commercial side of engineering. Therefore, he should be trained to do his duty, to do well and understandingly all of his work in any branch.

While he is learning to use the tools and machines of workshop production, he is pursuing studies in other departments. These include the materials of construction, the design of the machine and the laws governing its action, the theory of its construction and operation, and the qualities and characteristics of the material upon which he is

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working. If he has been earlier and rightly trained in the powers of observation, and the development of thought that comes with this knowledge, then the workshop practice puts him in a position intelligently to exercise thought and imagination about his work, and to see the connection between theory and practice. It gives him also the ability, when he has the opportunity, to devise, suggest and make improvements in tools and machines, in methods and processes of doing work.

The object of shopwork in this Institution is to train the student to use the various tools and machines in a workmanlike manner, and to understand the reasons for the different processes and methods of doing work, as well as to see the bearing which they may have upon engineering problems. Its aim and purpose is to do something more for the student than to make him a practitioner or a skilled mechanic. It aids him to crystallize into useful form many of the ideas and principles, which have been developed in his other work and studies. The shop instruction and practice thus develoy the ability in the young engineer properly to relate himself to his work.

The method followed is to teach the use of tools, at first, by a few simple exercises, each bringing in some new tool or method of handling the same. The instructor describes the use of tools, illustrates how they are used by workmen, and explains when and where the particular tools are used in manufacturing and other workshop production, and calls attention to the fact that some machine or process usually takes its place. He also points out when mechanical constructions similar to the exercise in hand are used, and when and where circumstances may render its modification desirable.

The machine tools are taken up in a similar manner. These early exercises are carried through to give the student some familiarity and skill in handling tools, so that when he takes up a problem in construction he may know at once what tools to use to produce desired results. Experience has demonstrated that the students get broader training and make more satisfactory progress later from these preliminary exercises as a result of carefully graded instruction and the employment of scientific methods than by any other system.

The time given to each branch of work is so short that but few problems in actual construction can be taken up by any one student. Therefore, as soon as each one has acquired some knowledge of the materials and some skill with the tools, it is desirable to make something involving several operations and elements of construction, with a direct view to its use. It should not be large nor elaborate, otherwise, it will require too much time, and the experience will be limited in handling the several tools and machines in successive stages of actual production. It is not anticipated that much skill of hand and speed of working will be acquired. These can only be attained through much repetition and long practice. As soon as the methods of doing a certain kind of work are understood, with the given tools and materials, something else is assigned the student.

It is quite desirable to give as much freedom of choice and to allow as much scope for individuality in doing work as is possible and consistent with workmanlike methods. After the general principles have been given, therefore, it is well to have the students themselves study out how to plan the work from the start to finish and to do the job. The instructor suggests how any new thing in the work may be

done, commending or criticising the plan and execution of the students as it follows or departs from workmanlike methods. This requires the students to think and to reason about their work and ensures a real benefit for them in shop training.

One of the earlier graduates of the Clarkson Tech. writes within the past month:

"Since my return from Potsdam I have bought a machine shop and the venture has been a success so far. It is on the basis of my earnings in the shop that I plotted the point for 1907."

Another more recent graduate writes:

"I am Superintendent and I find my shop experience comes in very nicely."

Various schools have different ways of giving shop instruction. The one in use when no shop facilities are provided, is to visit manufacturing establishments and require the students to observe and to report upon the methods of doing work. Another plan when the shop facilities are somewhat limited is that which is called the laboratory method, in which students learn to use the tools and machines by doing a set of exercises, but they do not make any number of complete or usable articles. Still another method, where extensive equipment and capital are provided, is to conduct the work as in regular manufacturing shops, in which the students have assignments for instruction and work but in which they may take part in the actual business of production on a commercial scale. Institutions of this last type employ journeymen and manufacture quite a line of apparatus and machinery, the students working in the shops as apprentices, under regular instructors and making such parts as they are capable of handling to advantage.

In the opinion of the writer, based on experience in shop training, manufacturing, teaching, and observation of many classes of work, it would appear that a judicious combination of the desirable features of the above three methods would yield the best results in the shop training of the engineering student.

The ideal would be manufacturing shops, well endowed and equipped, in which the students begin with a few preliminary exercises as explained in order to learn the use of the tools and machines. In this case, however, these exercises may be taken from the regular work of the shop, if they seem to meet the requirements from the educational point of view. Regular work as an apprentice would follow, and under competent instruction, from the boiler room to the office. Visits of inspection, if convenient, would be made to other shops, to be followed up by reports of the student's observations, of the work and methods examined: with reports and discussions of current technical literature throughout the course. The finishing work in such a school would include computing time and cost sheets, making and detailing orders, and carrying out routine of general office work.

In order to get the full benefit of shop training in such a course as outlined, much more time would be required than it is possible to give in the present four year curriculum for the engineering degree. It would be feasible to secure the benefits of such a combination, by utilizing portions of two or three of the summer vacation periods. It would thus be given at a time involving the least expense to the institution and the student. Moreover, the demand for change and physi-

cal exercise would thus both be satisfied, and in useful and educative work, without losing valuable time in seeking the conventional satisfaction of these wants.

THE DEMAND FOR MATHEMATICS.

By Samuel G. Barton, A.B., Ph.D.*

Mathematics has been termed the handmaiden of the sciences. Whether or not the mathematician himself accepts this as a truthful representation of his beloved science depends upon what the word "handmaiden" connotes. If it be used to designate a supposed inferiority either in value or respect, or a menial and degrading compulsory service, he justly rebels against such a metaphor. If, on the other hand, divested of all suggestion of inferiority ordinarily concomitant with the use of the term servant, the word is only construed to mean a voluntary, honorable assistance, then though deploring the use of a figure with such possibilities for false interpretation, he may not seriously object to its use. Mathematics undoubtedly does render incalculable aid to all exact and many other sciences.

Since mathematics antedates the other familiar sciences, astronomy excepted, its existence surely is not dependent upon their existence, nor can service to other sciences be its sole aim and object. It does not live to serve, alone. It is not a born slave. It has an existence absolutely independent of any use to which it may be applied. The mathematician has pursued and will pursue his investigations regardless of material profit. The unselfish motive which directs his activities as well as those of other pure scientists is that love of knowledge, pure and simple which seeks no reward other than the intellectual delight incident to the discovery of unknown truth, for him the revelation of hitherto unseen relations existent in the realms of number and space. However abstract and remote from practical application the truth revealed, matters not He is not and refuses to be guided by mercenary motives.

If, however, in the light of popular conceptions, the standard of appreciation of science be the extent or importance of its application to exigencies of daily life, mathematics gains rather than suffers from the lowering of the standard. Imagine, if possible, that we be suddenly deprived of all the amenities of our civilization which at some time and place in their evolution required the introduction of mathematical principles. Our fate would be even more pitiable than that which befell the "Connecticut Yankee." Words are inadequate to depict the transformed conditions. I can only offer as suggestions that all Trans-Atlantic and other foreign commerce would cease; for without astronomy, no navigation; and no astronomer without mathematics. America itself could not have been discovered. Columbus could not have conceived of the rotundity of the earth. The potency of commerce alone as a factor in the advancement of civilization cannot be exaggerated. Inland commerce would vanish, for the construction of locomotives, railroads, bridges, tunnels, and canals presupposes a con-

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siderable knowledge of mathematics. The trolley car and all electrical machines, large buildings, the printing press, power loom, all machinery not of the simplest construction, even our clocks and watches, yes, even the calendar on the wall would be removed.

We have not grasped, and cannot completely grasp the enormity of this indebtedness, but we must not repudiate it; we must give mathematics the honor and appreciation to which it has a just claim. Never was the application of mathematics more widespread, its services more sought than in the present day. I ask the reader to examine the following articles in the Encyclopedia Brittannica and thus see for himself the evidences of the prevalence of mathematical reasoning. The list is selected to exhibit a wide range of subject-matter rather than the amount or difficulty of the mathematics utilized. It should be noticed, however, that in every article, mathematics involving at least a knowledge of the calculus is employed. Articles whose contents are clearly of an extremely mathematical character are purposely omitted:—annui ties, arch, atom, calendar, capillary action, clock, comet, earth, elasticity, electricity, explosives, geography, gunmaking, heat, lubricants, magnetism, measurement, tide and time.

I now ask you to pick up a book above the elementary in the theory of light, sound, heat or electricity, or upon astronomy, or any branch of engineering, for example, Lord Rayleigh's "Theory of Sound" or a translation of Fourier's "Analytic Theory of Heat," or Maxwell's "Electricity and Magnetism"; and you may well inquire whether you have not a textbook upon higher mathematics. Heat and light perhaps do not appear to the man of the world as mathematical subjects. Examine, however, the encyclopedia articles on heat and wave theory.

The student should see early in his career that without sufficient, which is synonymous with the highest mathematical preparation, he is to be forever excluded from the reading and comprehension of these works. They are to be for him sealed books. The work is severely mathematical and with a knowledge of the mathematics employed the battle is more than half won. Ignorance of mathematics must ever set an upper limit beyond which he cannot go until that barrier has been removed. Some problems, notably that of three bodies, await, for their solution, more advanced mathematics than anyone now knows,—some new function or operation. Those realms of beauty whose grandeur is known only to those who have seen, must remain unseen or imperfectly apprehended by those whose vision is blinded or dimmed by the lack of the mathematical knowledge necessary to their proper understanding. Nor is it the exact scientist alone who weaves mathematics into the fabric of his science. The historian for his system of chronology necessary to the interpretation of ancient documents depends upon the mathematics of the astronomer. Even the historian of modern times has for his background upon which to project events an uniform and intelligible calendar. Disturb this background and history is confusion. The confusion of events incident to even so slight a change as the Gregorian reform illustrates this fact. And many modern political economists interpret the laws of society by means of mathematical equations and symbols, and it is even considered possible that the human brain may be found to conform to mathematical laws. Psychology is now rapidly tending toward an exact science. The derivation of Fechner's law embodies the integral calculus.

What more need we say? The extent to which natural laws may be discovered and expressed in mathematical equations must be a source of unending wonder. "Order is Heaven's first law". The mathematical equation is the apotheosis of order. It will ever be a matter of self congratulation to mankind that they can thus interpret natural phenomena by expressing the inexorable laws governing them in equations. We should better say that we are thankful to God for revealing to us those laws to which he has subjected his creation. It must ever compel a higher order of admiration for the Creator that he made things thus.

The student should early appreciate the importance of his mathematical training in his work, particularly in any subject of exact science. The haste made necessary by the limitations of time and the demand for more and more principles leave little time for mere application of known principles to explain nature, in a mathematics class. The utility of the study may thus not be as obvious to the inexperienced pupil as to the teacher. It is for the purpose of calling attention to some of these applications that these lines are written. The subject of mathematics should not be considered by the student as mere continued drudgery without ultimate gain. When those uninspiring successions of hooks and crooks are clothed with a garb of meaning provided by nature herself and their real import and significance made manifest, they command a proper reverence because of that which they have accomplished. The beauty of the truth revealed or explained sheds a sense of beauty even over the cold abstract reasoning.

The student should known that the knowledge which he dimly foresees will appear before him as a vast panorama of extended beauty when once he has become master of that most wonderful and powerful instrument of modern analysis, discovered by Newton and Leibnitz and so rapidly developed and applied by that constellation of immortal mathematicians, the Bernouillis, Clairaut, Euler, Lagrange and Laplace, namely the infinitesimal calculus. He will then have a deeper and keener insight into, and a partial comprehension of the plan and meaning of nature. Beauty hitherto concealed by ignorance of the mathematics necessary for interpretation will be revealed to him. He will then see that of which the untutored mind has no conception because lying beyond its comprehension.

The massive bridge once wonderful because of its enormous size, when its principles of construction are understood will be a thing of beauty, a wonderful monument to the intellect of the designer and constructor. The great tunnels, turbines, subways, which were once commonplace because of the ignorance of their construction will now be transformed as by a magic wand into objects of transcendent beauty. The stars in the universe above which nightly dissipate some of their light upon this earth bespeak their Creator's glory in voices but faintly heard by those whose senses are not quickened to perceive the full sublimity of the spectacle. To him whose training enables him to comprehend the reign of law, the heavens will declare the glory of God in a more real and exalted sense. The earth will be full of his glory. There will be veritable "sermons in stones."

One of nature's demands in which she is inexorable is a study of the higher, the highest mathematics. The interpretation of her laws requires it. Let me close by quoting from the writings of a scientist of universal fame. Sir John Herschel in the introduction to his "Out-

lines of Astronomy," writes: "The utmost pretension of this work is to place its readers on the threshold of this particular wing of Science, or rather on an eminence exterior to it, whence they may obtain a general notion of its structure." * * * * "Admission to its sanctuary, and to the privileges and feelings of a votary, is only to be gained by one means,—sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range."

NEW COURSES OF INSTRUCTION—1907-1908.

Economic Hydrology. A study of the supply, conservation, and utilization of water resources; climatology and physiography, as affecting water supply; rainfall and run off; forests and floods; stream flow, regulation, storage, and influence affecting river discharge; water resources and their conservation, and the power problem. Prerequisite Mechanics 3, (Hydraulics). Lectures and reports; accompanied by practical work in hydrography, study of selected rivers and their draining areas; methods, apparatus, apparatus and actual measurements of the river discharge. I.; arrange time; (2). Director Aldrich

Engineering Organization. A study of men with relation to organization and management in modern methods of production, construction, and operation of engineering work, and as related to the development of the business side of technical and industrial work. Prerequisite, Economics 3, 4, Lectures, readings, and reports. I.; II.; M., 3; (1). Director Aldrich.

Reinforced Concrete. Chemistry 29. General study of materials; cement, sand, cinders, gravel, crushed stone, and reinforcing steel. Proportioning materials to meet given requirements; commercial systems of reinforcement; making of forms and construction of reinforced columns, beams, arches, slabs, and walls. Prerequisite, Mechanics 6. Laboratory work, tests, and lectures. I.; Th., 1, 2, 3; (1). Professor Williams.

Hydraulic Construction. C.E. 15. Modern constructions; dams, conduits, water power canals, and irrigation works. Prerequisite, Mechanics 3, (Hydraulics). Lectures. I.; arrange time; (2). Professor McLeod.

Astronomical Observations and Computations. C.E. 22. Observations and computations to determine time, latitude, and azimuth. Prerequisite, C.E. 8, (Astronomy). II.; arrange time; (1). Professor McLeod.

Hydraulic Design. C.E. 38. Design of dams, conduits, penstocks and turbines; irrigation canals and tunnels. Prerequisite, Mechanics 3, (Hydraulics). Computations, drawings, etc. II.; arrange time; (2). Professor McLeod.

Design of Sewerage Works. C.E. 39. Modern plants for the disposal of sewage; typical plants using the various modern methods of disposal, such as, septic tank treatment, sewage irrigation, chemical treatment. Lectures and collateral reading. I.; arrange time; (2). Professor McLeod.

Mechanics of Reinforced Concrete. Mechanics 6. Theory of reinforced columns, beams, arches, slabs, walls; graphical analysis of arches. Prerequisite, Mechanics 2. Lectures and problems. II.; arrange time; (2) or (3). Professor McLeod.

Advanced Calculus. Math. 9. Advanced work in differential and integral calculus; mechanical differentiation and integration; calculus of imaginaries; hyperbolic functions; elliptic integrals and elliptic functions defined. Lectures, accompanied by assigned reading and problems. Prerequisite, Math. 5. II.; arrange time; (2) or (3). Professor Barton.

Determinants. Math. 10. Definitions; minor determinants; addition and multiplication of determinants; rectangular arrays; solution of equations by means of determinants; symmetrical determinants; skew determinants. II.; arrange time; (1) or (2). Professor Barton.

Solid Analytic Geometry. Math 14. Lines and planes in space; the ellipsoid; hyperboloid, paraboloid, sphere, cylinder, cone, and surfaces of revolution. Prerequisite, Math. 12. Text: C. Smith, Solid Geometry. II.; arrange time; (1) or (2). Professor Barton.

Seminar. Math. 16. The history of mathematics; selected topics in the lives and work of great mathematicians; readings and reports upon assigned articles; class discussion of the topic. Open to all students. I.; II.; arrange time; (1). Professor Barton.

APPOINTMENTS ON THE INSTRUCTIONAL FORCE.

The following appointments have been made by the Board of Trustees:

William Alfred Yerzley, M.E., Pd.B., to be Professor of Mechanical Engineering, vice Frank R. Swift, S.B., resigned.

Mr. Yerzley's training and experience have been as follows:

M.E., Cornell University, 1892; ibid., 1892-1894; Pd.B., New York State Normal College, 1895; graduate student, Columbia University, School of Mines, 1897-1898. In charge of machine shop and drafting department, Miller School, Va., 1895-1897. College preparatory teaching, Madison School, New York City, 1898-1899. Director, Engineering School, Buffalo, N. Y., 1903-1905. Engineering work: Laboratory of Thomas A. Edison, Orange, N. J. 1899-1900 and 1901: with Babcock & Wilcox Co., Bayonne, N. J., 1900-1901; Mergenthaler Linotype Co., New York, 1901-1902, and 1906; Stanley Instrument Co., Great Barrington, Mass., 1902-1903; New York Adding Typewriter Co., 1905-1906; Clark Thread Co., Newark, N. J., 1906-1907.; Crocker-Wheeler Co., Ampere, N. J., 1907, to date of appointment, Sept. 1.

Samuel Goodwin Barton, A.B., Ph.D., to be Professor of Mathematics and first incumbent of Chair established by the Board of Trustees, September 13, 1907.

A.B., Temple College, Philadelphia, Pa., 1903; graduate student in mathematics, astronomy and physics, University of Pennsylvania, 1903-1906; University Scholar, 1903-1905; Harrison Fellow in Astronomy, 1905-1906; Ph.D., 1906; Harrison Research Fellow in Astronomy, 1906-1907 and 1907-1908, to date of appointment; in computing staff, U. S.

Naval Observatory, Washington, D. C., summer of 1907. Member of the Society of Sigma Xi.

J. P. Schrodt, '08, to be Assistant in Technical Photography.

B. W. Morse, '09, to be Assistant in Physical and Electrical Laboratory, vice G. L. Eastman, '09, resigned.

RECENT APPOINTMENTS OF CLARKSON GRADUATES.

1900.

Julius R. Jacobson, B.S. in Electrical Engineering, Foreign Construction, General Electric Company, San Paulo Tramway, Light and Power Co., San Paulo, Brazil.

Charles H. Lawrance, B.S. in Electrical Engineering. Instructor in Mechanical Engineering, Purdue University; mail, 1022 First Street, W. Lafayette, Ind.

1901.

John E. Harriman, B. S. in Electrical Engineering, Proprietor, General Machine Works; Excelsior Springs, Mo.

William H. Wilcox, B.S. in Civil Engineering, Assistant Engineer, Waterville, N. Y., Waterworks; mail, Lowville, N. Y.

1902.

Otis C. Loomis, B. S. in Mechanical Engineering, Engineer and Superintendent, H. G. Hinkle, Inc., Engineers and Contractors, 55-59 Central Trust Building; mail, 408 Pine Ave., Altoona, Pa.

Charles A. Pohl, B.S. in Civil Engineering; with John Bogart, Consulting Engineer, 16 Exchange Place, New York City.

Carlton E. Ward, B.S. in Civil Engineering; Assistant Engineer, Northern Pacific Railroad Company, Minnesota and Dakota Division; mail, Detroit, Minn.

1903.

J. Everett Beswick, B.S. in Civil Engineering, Board of Water Supply, City of New York; Cold Spring, N. Y.

George O. Hodge, B.S. in Mechanical Engineering; Superintendent, The Kingston Motor Company, Kingston, N. Y.

1905.

Harry B. Claflin, B. S. in Electrical Engineering; Best Manufacturing Co., Pittsburg, Pa.; mail 6358 Aurelia St., E. E. Pittsburg, Pa.

Chester E. Hudson, B.S. in Civil Engineering; Chief, Engineering Department, Western Division, Manufacturers' Automatic Sprinkler Co., 920-923 Association Building; mail, 2520 North 41st Ave., Irving Park, Chicago, Ill.

Michael L. Stack, B.S. in Electrical Engineering; The Connecticut Company; mail, 110 DeWitt St., New Haven, Conn.

Silas S. Stone, B.S. in Electrical Engineering; General Electric Company, Kittredge Building; mail, 1435 LaFayette St., Denver, Col.

1906.

Ceylon R. Cady, B.S. in Mechanical Engineering; Hinchman & Grylls, Engineers and Architects; mail, 114 Bagg St., Detroit, Mich.

Mildred M. Parker, B.S. in Home Economics; Teacher of Domestic Science, Plainfield Public Schools; mail 214 East 5th Street, Plainfield, New Jersey.

Howard S. Phelps, B.S. in Electrical Engineering, Denver branch office of Dr. F. A. C. Perrine, Consulting Engineer, 60 Wall Street, New York City; mail, 1244 Grant Ave., Denver. Col.

1907.

Leon C. Craig, B.S. in Civil Engineering; Guanico Centrale; mail, Box 32, Ponce, Porto Rico.

M. Francis Dullea, B.S. in Civil Engineering; Surveyman, Engineering Department, U. S. Army Building, New York City; mail, 14 Pine Street, Newark, N. J.

Floyd R. Finch, B.S. in Electrical Engineering; General Electric Company; mail, 35 Dalton Ave., Pittsfield, Mass.

Claude F. Gleason, B.S. in Civil Engineering; Junior Engineer, United States Reclamation Service; mail, North Yakima, Washington

Jean H. Hawley, B.S. in Civil Engineering; United States Coast and Geodetic Survey, Washington, D. C.

Robert C. Huntington, B.S. in Electrical Engineering; General Electric Company; mail, 201 Seward Place, Schenectady, N. Y.

Archibald W. Meacham, B.S. in Civil Engineering; Draftsman, U. S. Navy Yard; mail, 261 Carlton Ave., Brooklyn, N. Y.

Charles D. Owen, B.S. in Electrical Engineering; General Electric Company; mail, 514 Union St., Schenectady, N. Y.

David D. Thomson, B.S. in Civil Engineering; State of New York Improvement of Public Highways; mail, 253 Church St., Poughkeepsie, N. Y.

Ivan R. Wellington, (A.B., St. Lawrence University, 1901), B.S. in Civil Engineering; Pennsylvania, New York and Long Island Railroad; mail, 237 East 32nd St., New York City.

Ray D. Wiswell, B.S. in Civil Engineering; State of New York Improvement of Public Highways; mail, 306 Sherman St., Albany N. Y.

HOLDERS OF CERTIFICATES.

Two Year Course in Home Economics.

1906.

Sarah E. Bush, Instructor in Domestic Science, Hillside Home School, Hillside, Wis.

Corinne M. Frame, Teacher of Drawing and Manual Training, Rome Public Schools; mail, 420 W. Thomas St., Rome, N. Y.

1907.

Lucy Fulton, Teacher of Domestic Art, Yonkers Public Schools, mail, 130 South Broadway, Yonkers, N. Y.

Stella C. Mott, Teacher of Domestic Science, Wilmington Public Schools; mail, 219 South 5th St., Wilmington, N. C.

Katharine A. Signor, Supervisor of Domestic Science and Art, Marquette High and Manual Training School; mail, 400 East Arch Street, Marquette, Michigan.

ALUMNI PERSONALS.

1900.

Charles H. Lawrance, formerly Instructor in Drawing and Mechanics, in the College of Agriculture and Mechanic Arts, at West Raleigh, N. C., has been appointed Instructor in Mechanical Engineering, in Purdue University, at Lafayette, Ind. His work comprises instruction in mechanics, senior machine design, with special reference to gas engines, and assisting in the steam laboratory. Mr. and Mrs. Lawrance visited Potsdam during the summer before going west.

1901.

John E. Harriman, formerly with the Home Telephone Company, of Kansas City., Mo., has purchased and become proprietor of a general machine works, at Excelsior Springs, Mo., and is busy with a large amount of repair work, for which his shops are fitted, including automobiles, steam and gas engines, and electrical machinery.

William H. Wilcox, formerly in charge of construction work, on the Lowville & Beaver River R. R., has recently been putting in a new reservoir for the water supply of Waterville, N. Y., of capacity of 25,000,000 gallons.

1902.

Otis C. Loomis, who has been engineer and superintendent for D. F. O'Rourke, Contractor, Altoona, Pa., has assumed similar duties for H. G. Hinkle, Inc., with offices in the Central Trust Building, of that city.

Charles A. Pohl, formerly Assistant Engineer, New York State Barge Canal, located at the Residency office, at Lyons, N. Y., has become associated with Mr. John Bogart, Consulting Engineer, of New York City. He is now busily engaged in preliminary and office work for the water power development which Mr. Bogart has in hand, in Tennessee, and will soon remove to the site of the work. Mr. Pohl was recently elected Associate Member of the American Society of Civil Engineers, and on October 16th, attended the meeting at the rooms of the Society, 220 West Fifty Seventh Street, New York City.

Charles B. Richardson, electrical engineer, with the Wagner Electric Manufacturing Company, of Chicago, was united in marriage to Miss Ida Haas, at the home of the bride's parents, at Clayton, N. Y., June 27, 1907.

Carlton E. Ward, has recently been engaged as assistant engineer, for the Minnesota and Dakota Division of the Northern Pacific Railroad Company, in charge of work at Detroit, Minn., and will return to Minneapolis before the close of the year.

1903.

Benjamin F. Batchelder was united in marriage to Miss Emma May, at the home of the bride's mother, Mrs. Lydia Walter, 109 Sycamore Street, Ravenna, Ohio, on Wednesday evening, October 23, 1907, at six o'clock. Mr. Batchelder has been engaged by the firm with which he is associated, Messrs, Williams, Proctor & Potts, Sanitary Engineers, of New York City, in the construction of extensive sewage system for the city of Ravenna, Ohio.

J Everett Beswick has been transferred to the Board of Water Supply, of the City of New York, with work at present located at Cold Spring, N. Y. He is still engaged in tunnel construction, with which

he became quite familiar, while in the employ of the Rapid Transit Railroad Commission, of New York City. The portion of the new Aqueduct upon which he is now at work, is a tunnel for a distance of two-and-a-half miles, at hydraulic grade, working now from the north portal and a shaft, which when it is completed, will be a mile-and-a-half farther south, or half way between the portals, from which shaft headings will be driven toward each portal.

George O. Hodge, who was associated with the New York Car and Truck Company, at Kingston, N. Y., has become superintendent of the newly organized Kingston Motor Company, as a result of a large amount of experimental work on automobiles, which he carried out last winter, for the parties interested.

1904.

Ralph D. Hayes, located at the Middletown Residency of the New York State Engineer Department, was united in marriage to Miss Genevieve Mercy, daughter of Mr. and Mrs. D. E. Denneen, at the home of the bride's parents, Fort Covington, N. Y., on Tuesday, September 3, 1907. Miss Denneen was a graduate, Class of 1902, from the two-year course in Home Economics, of the Clarkson School of Technology, and was formerly supervisor of Domestic Science, for the Public Schools, of South Orange, N. J. Mr. and Mrs. Hayes were at home to their friends, after the first of October, at Middletown, N. Y.

F. C. Zapf, B.S. in Chemical Engineering, Chemist, with the General Electric Company, Schenectady, N. Y., was recently detailed for special investigations at the Harrison, N. J., Lamp works of the Company. He organized and developed a new department for the treatment of the crude material in the manufacture of the tungsten lamp. In this lamp, which is of the incandescent type, the carbon filament is replaced by one of metalic tungsten. The tungsten lamp produces about three times the amount of light, as measured in candle-power, for the same current, as the ordinary carbon-filament lamp; or, the same amount of light, for about one-third the current consumption. The quality of the light is also much improved, being of a brilliant white instead of an orange-yellow glow.

1905.

Harry B. Claflin, B.S. in Electrical Engineering, has become connected with the Best Manufacturing Company, of Pittsburg, Pa. He has charge of the pricing and general care of the estimating departments, being directly responsible to the assistant and sales manager, for the correctness of all estimates. This Company manufactures high pressure steam goods, and brass fittings, and contracts for the piping of steam and hydraulic power plants, in which special lines of work, Mr. Claflin has found opportunity to be of much service to the Company.

Clinton A. Curtis, B.S. in Civil Engineering, and located at Fort Edward Residency of the New York State Barge Canal Work, has been admitted to Junior Membership, in the American Society of Civil Engineers.

Lloyd W. Greene, B.S. in Civil Engineering, has received successive promotions, in the employ of the R. W. & O. Division of the New York Central Railroad Company, and having recently a large amount of outside field work, has fortunately been thrown in contact with many of the Clarkson Alumni. As Treasurer of the Clarkson Engi-

neering Assembly, he has brought up the Gymnasium Building Fund, through Alumni subscriptions collected, to the amount of $975.11, Oct. 31, 1907.

Chester A. Hudson has been appointed Chief of the Engineering Department, of the Manufacturers' Automatic Sprinkler Co., with headquarters in the Association Building, Chicago. Mr. Hudson has three associates with him, and reports more than enough work to keep him busy; but he would be glad to see Clarkson men drop in upon him at any time, at his new home, 1520 North Forty First Avenue, Irving Park, Chicago, where he and Mrs. Hudson are keeping house.

M. L. Stack, B.S. in Electrical Engineering, has been actively engaged in the power developments and layout-work of the Connecticut Company. At recent writing this Company had in operation thirty-five power plants, and twenty-six substations, with about five additional substations under construction, and six or eight in view, of the 22,000-volt design, one of which will be for use on the New London-Charlton City division. The Company has adopted what is known as the Gravity Centre Distribution for one of its important systems now in operation.

Silas S. Stone, B.S. in Electrical Engineering, has become connected with the Colorado work of the General Electric Co., after a considerable experience in the Schenectady work of the Company, the last of which was in the Turbine Testing department, with Harold S. Dunsford, B.S. in Electrical Engineering, '05.

1906.

Carl C. Ahles, in the State of New York Improvement of Public Highways, has been promoted to Leveler, as result of civil service examination, and is now located in the work of the department, at Kerhonkson, N. Y.

Ceylon R. Cady, B.S. in Mechanical Engineering, formerly with the Weston-Mott Company, of Flint, Mich., has become connected with Messrs. Hinchman & Grylls, Engineers and Architects, of Detroit, Mich. In this capacity he has recently worked out the details of the designs for several power plants, and has been conducting power plant tests outside of the city. He was engaged for a week at Hillsdale, Mich., with two engineers and a chemist, testing the city lighting and pumping station. Later he was sent to Mt. Pleasant, Mich., to make a complete test of the power plant for a firm manufacturing wood veneer the object being to ascertain the power consumption, reduce the cost of operation and to modernize the plant. This occupied three weeks and was carried through by Mr. Cady, in entire charge.

Francis P. Cummings, B.S. in Electrical Engineering, has been in the distribution branch of the engineering department, of the Denver Gas and Electric Company, and has had much interesting and important work in laying out new street lighting distributing systems, and in re-designing old systems. The Company has charge of all the lighting and power work together with the street and other municipal lighting. The Company takes on quite a number of technical graduates, each year, from several of the engineering colleges. While trying to devise some means to accommodate the increasing number of young graduates that come into the employ of the Company, Mr. Cummings initiated a plan leading to the organization of a Club. It is thus described, in the Electrical World, of September 7, 1907, Vol. 50,

page 442: "A Denver Organization.—The members of the School of Gas and Electric Practice, conducted by the Denver Gas & Electric Company, Mr. Henry L. Doherty, president, have recently organized a social and athletic club to promote good fellowship among the college men engaged in engineering work in Denver. The society is known as the 'El Diablo Club', and is composed of about thirty members, representing the following colleges and schools: Dublin, Clarkson, Queen's, Cornell, Columbia, Lehigh, Lafayette, Georgia Tech., Purdue, Rose, Michigan, Illinois, Wisconsin, Missouri, Colorado, Ohio State, Washington State, California and Armour."

Roger D. Flint, B.S. in Civil Engineering, with the Pennsylvania New York and Long Island Railroad Company, was united in marriage to Miss Anna, daughter of Mr. and Mrs. Herbert Maynard, of Potsdam, N. Y., on Monday morning, August 19, at the home of the bride's parents. The Rev. J. Stallwood, Pastor of the Methodist Church, Potsdam, officiated; and immediately after the ceremony the young couple left for a trip through the Adirondacks. Mr. and Mrs. Flint were at home to their friends, after September the ninth, at Flushing, Long Island.

Ralph B. Leonard was united in marriage to Miss Grace Lupet, daughter of Mr. and Mrs. William J. Hendry, at East Aurora, N. Y., on August 20, 1907. Mr. Leonard has been connected since graduation with the General Electric Company, Schenectady, N. Y.

Howard S. Phelps, B.S. in Electrical Engineering, with the Denver Gas and Electric Company, has been conducting some special investigations in the gas department of the Company, under the direction of Mr. Henry L. Doherty, President, and in the tests on the new water-gas machine, being developed by the Improved Equipment Company. Quite recently he was transferred to the Denver office of Dr. F. A. C. Perrine, where he is now located and at work on a project for the development of power in the central part of Colorado. Dr. Perrine, it will be remembered delivered the Founder's Day address, at the Clarkson School of Technology, November 30, 1903, on "The Success of the Educated Man", published in full, in the Clarkson Bulletin, Vol I, No. 1, February, 1904. The work which Mr. Phelps has been engaged in comprises the field work for a hydroelectric development, in central Colorado, of four thousand horsepower, under a net head of water of four hundred and fifty feet, and for transmission to a distance of eighteen miles, at twenty-two thousand volts.

Abel F. Simpson, B.S. in Civil Engineering, in the Maintenance of Way Department of the New York Central Railroad Company, was united in marriage to Miss Jennie D. Aberle, at the home of the bride's sister, Mrs. William A. Thaler, West Gibson St., Buffalo, N. Y., on Tuesday afternoon, September 20th, at one o'clock, the Rev. Livingston L. Taylor, officiating. Mr. and Mrs. Simpson, immediately after the wedding dinner, left for Montreal and the Adirondack Mountains. Upon returning they took up their residence in Buffalo, as Mr. Simpson has recently been advanced to an important position in this division of the New York Central Railroad.

1907.

Leon C. Craig, has been appointed to a position in the Civil Engineering department of the Guanica Centrale, in Porto Rico. He has

been on the island since July 4th, and has found the work and environment especially interesting and valuable.

Maurice F. Dullea has been working with the United States Engineer Department at large, since August first, with headquarters in the U. S. Army Building, New York City. At present he is located at the branch office, at Elizabethport, N. J.

Floyd R. Finch was united in marriage to Miss Alice Emmons, daughter of Mr. and Mrs. Cornelius B. N. Hull, at Livingston Manor, N. Y., at eight-thirty o'clock in the evening, June 25, 1907, at the home of the bride's parents. Mr. Finch has become connected with the General Electric Company, Pittsfield, Mass.

Claude F. Gleason has, as a result of Civil service examinations, been appointed Junior Engineer, in the United States Reclamation Service, with his present headquarters at North Yakima, Washington.

Jean H. Hawley, formerly engaged with the corps of draftsmen at the New York Navy Yard, has been appointed to a position in the United States Coast and Geodetic Survey, Washington, D. C., as a result of civil service examination.

Robert C. Huntington is associated with Harold S. Dunsford, '05, in the turbine testing department of the General Electric Company, at Schenectady, N. Y.

Archibald W. Meacham is engaged with corps of draftmen, at the New York Navy Yard.

Charles D. Owen is with the General Electric Company, and reports something doing most of the time, and times interesting when he can muster some of the Clarkson Old Guard with the Decennial Songs around the camp fire at Schenectady.

David D. Thomson, formerly with the R. W. & O. Division of the New York Central Railroad, at Watertown, N. Y., has became connected with the State of New York Improvement of Public Highways, and is located at the Residency Office, Poughkeepsie, N. Y.

Ivan R. Wellington has been connected with the Pennsylvania, New York and Long Island Railroad, and is completing arrangements to enter upon a new field of railroad work in Brazil.

Ray D. Wiswell, formerly located with the Benson Mines Co., has become connected with the State of New York Improvement of Public Highways, and is located at Albany.

TECHNICAL PHOTOGRAPHY.

By John P. Schrodt, '08.*

Photography in its broadest interpretation is both an art and a science. If we inquire into its utility, as noted in its many applications, we cannot but admit that in few of them has it rendered greater service, or proven of more valuable assistance, than in architecture, engineering, and the applied sciences.

The artist finds in photography a means of expression for his appreciation of the beautiful. The scientist and engineer welcome it as a faithful aid, an additional and invaluable instrument of service in his profession. To the architect as well as the artist, photography is

*Holder of Scholarship, Assistant in Photography, 1907-1908.

both a pleasure and a necessity. By its aid the greatest masterpieces of art have been rescued from oblivion, by being faithfully reproduced by photography. No patience or skill of man, however, can reproduce in black and white the marvelous works of the great painters. The best works of the most skillful architectural draftsmen can only approximate the correctness of perspective, the fullness of detail, the accuracy of curvature, and a complete subordination of the detail to the general effect as is found in a well made photograph of a building, for instance.

By means of photography, the engineer and architect of today have within reach a veritable panorama of the world's great works. It is of inestimable value to them in all preparatory studies and designs. They are able to bring together for close comparison the different styles and to put side by side transcripts of all the buildings that seem to offer suggestions. With a good collection of photographs for example, an architect makes the range of the entire architectural world with an accuracy of observation and a fullness of detail quite impossible without photography.

Not only is photography important to the architect but also to the engineer. It plays an important part in the everyday work of modern railroads, structural work of all kinds, machine shops, and manufacturing establishments. Some companies maintain a regular photographic department for the work. Others have capable men on call in different sections of the country in which their work is carried on for the time being. Several companies give work out as the occasion requires.

The duties of a railroad photographer are legion. They comprise the photographing of bridges, culverts, stations, signal-cabins, train sheds, sidings and the general equipment of the road. Aside from this emergency work is always to be included. Whenever an accident occurs the photographer is dispatched to the spot, and photographs are made from every point of view for the use of officials of the road, or perhaps to be used in court, if the accident brings legal trouble in its wake.

In other ways, also, in railroad work every department interested is furnished with a full set of prints bearing upon its work. When improvements or changes are planned, or alterations are to be made along the road, the officers in charge of the work have photographs showing present conditions, with views of the locality concerned. They may then intelligently direct the work, or judge of its progress without visiting the spot. The saving of time and the impartiality of the evidence thereby provided is apparent.

A high grade of work is required for such a photographic department. The railroads are willing to pay fair prices for desirable material, so that the field is one worth cultivating from a business viewpoint. A survey of the many railroad hand-books advertised in the monthly magazines will give some idea of the scope of this field. These do not, however, illustrate the mechanical or technical applications of photography in railroading, such is its use in reconnaissance, preliminary surveys for location, and topographic work. These belong more especially to the construction or permanent way department.

In the modern machine shop, as another illustration, photography is considered only second in importance to draftmanship. Workshop photography also includes supplying photographs of the various pro-

ducts of the establishment, to serve for advertising purposes. These photographs are usually made from a point of view that will most readily show the machine as a whole, substantially as it would look to an observer standing by its side or in front. Unfortunately, this does not always give to an intending purchaser any very clear idea of its construction or the arrangement of the working parts. However, in many cases it will prove sufficient. Occasionally a prospective purchaser desires to be further informed regarding points which are only obscurely shown in these general views of the machinery. To enlighten him in these features it may be necessary to make other views which in almost all cases are willingly furnished as he may specify.

Photography may be of considerable use in making copies of standard drawings. These may later be bound in book form, each book containing a complete set of working drawings of each machine. These drawings may then be readily carried about by the traveling salesman. With the detail photographs of the machine itself, they serve to illustrate most intelligently the machine to be sold.

In the foundry, a photograph taken in the process of moulding a complicated piece may similarly be of great value for future reference. Should the same piece be ordered again, the photograph may be the means of saving considerable money in its manufacture a second time, and especially if a new man has to do the work.

In general, therefore, photography is one of the accomplishments in which a good engineer should be well posted. In it he may become quite skillful with a little care and frequent practice. He will find that as the camera habit develops he will become a close observer of details. It will encourage him to look at things from many points of view, and with an eye to their more complete and satisfactory illustration as in projected work and reports or memoranda of the progress of construction work.

OREGON AND THE PACIFIC COAST TRADE.*

Industrial and Engineering Developments in the Northwest.

By John McNulty, ('09).**

There have come down to us from some thousands of years ago the legend of Jason and his gallant adventurers who went in search of the Golden Fleece. They were as gallant as the best of their times, and followed the rule of those days, seeking honor and wealth by the swing of their bronze swords. If Jason and his band lived nowadays, they would be typical hustling young soldiers of Industry, fitting into the times and seeking honor, wealth, and happiness by the swing of

*This is the second of a series of articles by Clarkson men, regarding trade conditions, business prospects, and industrial and engineering developments in their new environment. The first was published in Clarkson Bulletin, III:188, October, 1906, "Graduates and Undergraduates: A word from the West to Clarkson Men"; by Chester E. Hudson, '05.

**Formerly Class, '09, Thomas S. Clarkson Memorial School of Technology. Nautical Expert, U. S. Navy Dept., In charge Branch Hydrographic Office, Portland, Oregon.

their intellects sharpened by four years attrition in a college of engineering for the training of men. They would serve in the progressive army of Civilization in the departments of Construction and Development. They would exploit the resources of Mother Nature; they would use their scientific acquirements to demolish the Rocky Mountains in search of gold; to pierce them with tunnels for the advance of railroads; to curb the wild streams and harness their energy to turn wheels performing stupendous tasks, repeating the role of Hercules in a modern guise. Their draught of knowledge would contain elements from the concentrated experiences of workmen of all ages and lands and when properly digested and absorbed, it would furnish the incentive and ability to essay the Great Task that men have tackled since the world began. It would enable them to make of themselves forces which their times would feel; to do things that would push the Cause a notch onward, and to leave foot-prints in the shores of time that would be petrified by the thankfulness of posterity, something for the man of the future to think upon and to follow.

I have spoken of the Golden Age as of the past. There has never been a time when that title could be applied more truthfully than today, and in relation to the life of the great Northwest. What was, was legend: what is, is fact. Never in the history of our land has success proffered to the young engineer all the bounty that success alone can offer, and render him more certain of a possession than now. I am not getting a stipend from the Chamber of Commerce of Portland for acting as a "boomer". But when one has been in the state of Oregon for even a short time and has come in contact with its thriving, youthful industries, and has had his mind almost bewildered by the wealth and prodigality of its untouched resources, he will become an independent boomer, like every Oregonian that is able to speak. Facts contain the seed of progress: the seed germinates and produces good co-operative boomers, and Oregon rolls on.

Taken unawares, I was ordered by the Chief to produce this document, and in the short time I have had, it must be made up of the facts that have come to hand.

The questions are, "Is this wonderful growth we hear of true?" "Why?", and "What about the young engineer's prospects in the field?" Taking into view the following facts, statistics, and true generalizations the first question answers itself.

The Easterner must divest himself of preconceived notions of Oregon. I thought, that inasmuch as it was discovered by Capt. Gray, in the ship Columbia, about 1798, that it was old enough to take care of itself; and that, if new, as we had heard, yet it was in the middle-age state. This was wrong. Oregon is really new. It is in the natural state and not so much in need of nourishment and encouragement as of development, and the technical man is the one to fill the place.

The greenness of the land dawned upon me while looking from the car window on my way south from British Columbia. Forests stretched for hundreds of miles,—great, tall, sky-piercing fir trees. Here and there, at infrequent intervals, a rough lumber mill with a cluster of straggling cabins would flash into view and out again. We saw a few good-sized cities, but their sidewalks needed repair, paving for the streets was in demand, and their docks were of the old fashioned timber kind. In the woods or along the beach, huge piles of sawdust, shavings, and scrap lumber burned. The scrap lumber was such as in

the east would be carefully saved and used. The trees are found sometimes fifteen feet through at the but, and the slabs that are thrown away are sometimes six or eight inches thick. All of this by-product is burned because of poor economy and lack of transportation facilities, while in Portland, a city of 215,000 population, there is a continuous demand for stove-wood, packing material, and stable-bedding. On this trip I found no farms, fields, fences, cattle, and poultry such as one sees in the east making up the picture for the traveller. There are a few sections such as the Willamette Valley here where dairying farms are to be found, and even here very few of them. For this reason farm produce of the dairy variety is dear.

Dark interminal forests stretch to the northward, with untouched mountains and unused waterpower. Stage coaches with from two to six horse teams attached are a common sight. From the drummers' yarns, their rides are as exciting as in the old '49 days. From the Southern Pacific Railroad to the sea, these coaches are the only means of transportation. The towns on the coast are rich. Two or three of them have as fine harbors as can be found anywhere, and do a large business with deep sea craft. Harriman, it is now said, is after these places with a $30,000,000 outlay. Hill is following hard upon his heels and soon these towns will be thriving cities. Marshfield lately raised $50,000, in one week, to build a hotel. It is this state of affairs which demands the attention of the engineer, and I assure him that his brain-capital invested will not be put into a game of chance.

By the Government reports there are 20,000,000 acres of unoccupied land in Oregon alone. The Geological Survey states that there are mines of proven value, forests and irrigable territory. Hundreds of square miles with not a railroad to transport the produce. This is a snap-shot, an indefinite picture of Oregon, that part outside of Portland.

Portland is the metropolis, and at present is in the center of this stage in the development of the Pacific Coast. It is situated on the Willamette river, twelve miles from its junction with the Columbia, and ninety-eight from the sea. It has doubled its population since 1900. In 1906 it gained 309 per cent. in buildings, and in many instances the value of real estate went up to threefold its original. It is the most eastern city in the west, in point of character, and possesses excellent schools, churches, Federal buildings, a large Armory, and several steel bridges. A very large bridge is being built across the Columbia—the first time this river has been spanned—and affords now another opportunity for skilled constructors. Portland also possesses fine theaters where the best talent in the world performs, which is something rare in the west. This city is known as the Rose City, because of its innumerable roses which bloom almost all the year around. Whole gardens of them are even now in bloom.

Speaking of the Harriman and Hill passage at arms in railroad construction, I will mention that one of them has almost finished a freight-terminal in the city, nearly nine hundred feet long. It was estimated that this autumn 50,000 settlers would arrive here from all parts. To illustrate Portland's magnetic power, I will say that I have met five people from Potsdam, since July 1st, 1907. This year there were shipped from this port more lumber and grain than from all the other Pacific coast cities combined. Portland ranks third as a wheat port in the United States. Messrs. Swift & Co. are erecting here one

of the largest packing houses in the west, intending to make this their shipping port for exports of meat to the far East, China, etc.

Of interest to electrical engineers we have one of the largest transmission lines in the world. The plant uses 19,000 horsepower for light and power, of which 6,000 kilowatts are produced by water power and the remainder by steam. In Cazadere, a suburb, a 15,000 horsepower plant was recently completed. Portland is now the terminus of twenty-one railroad and steamship lines, reaching, by regular trains and boats, from Hong Kong to New York, and from Alaska to the United Kingdom.

With this type of an industrious city, prosperous and wealthy, as the center of operations, the State of Oregon is just now awakening to a realization of its possibilities in the years to come, with a wealth of resources practically untapped. Thousands of immigrants are pouring in every year. Capitalists are eager to invest. Values are steadily going up. Do you hesitate to believe that it would be good policy to put your ability and the results of your technical training as your working capital into this land? The question is answered. For men in school, busily engaged in providing themselves with tools to work with, this is probably uninteresting; yet it is what they will run up against after graduation, or perhaps earlier; and a peep into the future is not a bad sight.

Are you interested in mining? Here are some facts that are not taken from Wild Cat Bulletins, but from the right sources. My every day work brings me into contact with the most prominent men in the development of the state, and I get my knowledge from them.

Grant's Pass is the heart of Southern Oregon, a region with 5,000 square miles. It is a mining district. It has been prospected one-tenth and mined one-twentieth. There are now 150 Placer mines in operation, each being equipped with hydraulic machinery, and some of them employing batteries of three and four giants working under gravity pressure of from 200 to 450 feet; there are 2000 miles of ditches and pipe lines; 500 men working during the wet season; an annual output of virgin gold of $1,500,000 value. There are no smelters, and the ore has to be sent away. Here is a field for betterment, of which a hustling young engineer should take hold.

There are twenty-two quartz mines in the state, and during the year of 1906, $500,000 was put into them for improvements. They run from 200 to 300 stamps. The big ledges and unquestioned values will draw the big milling operators. In this line also the technical man will have openings in which to make reputation and fortune. Rogue river has been harnessed by a large dam, developing 6,000 horsepower. This is transmitted through electric wires, aggregating 600 miles in length, furnishing the power used in the mines. The Golden Drift Mining Co. also has a 5,000 horsepower hydraulic development. Hundreds of locations are now lying waste because of the lack of money, energy or enterprise to bring out the best results. Owing to the character of the land slope and the abundant rainfall, rapids and falls are found by the hundreds. The Wounded Buck Mine turned out $40,000 in gold in one week. It is reported that Preston Peak is nearly a mass of high grade copper ore. I have seen specimens of all of these ores in the engineering offices of the city. According to the United States Geological Survey, there are in Oregon 2170 mines under development, furnishing the world with gold and copper, primarily, and also with

coal, iron, platinum, cobalt (for Edison), cinnabar, saltpetre, caolin, and antimony. There are also deposits of grindstone material; oil and gas are as yet undeveloped resources.

If you are to devote yourself to railroading, there are ample opportunities to become connected with the Harriman or Hill lines, and to learn by experience how a country is developed, and to develop yourself at the same time in position, ability, and reputation.

As for Hydraulic work, the United States Government is placing men in the Klamath country, on a project for the irrigation of 250,000 acres of rich lands. The main canal is completed and 13,000 acres will receive water during this year. Umatilli county is receiving attention to its 20,000 acres. At Celile falls the Government is building a canal that will open the Columbia river to water transportation from Portland to Idaho, eastern Washington and Oregon, where every year 50,000,000 bushels of grain are grown, and yet it is claimed that the industry is still in its infancy. The United States Reclamaton Service is spending at the present time, $10,000,000 to irrigate lands within Portland's trade radius. This serves to show the future outlook for young engineers in the Northwest.

If as a workman in the ranks of Industry one care to develop economic manufacturing, I would again refer to the lumber question as limited to Portland City. We have here a capacity of 2,000,000 feet per day, and the 1906 cut totaled over 643,000,000 feet, the largest lumber-cut of any city in the world. A short time ago, becoming acquainted with the fact that these lumber companies in this part of the Union run their own lines of sea transportation, I called on the manager of one of them in order to bring my office into contact with his captains. I found to my surprise that he ran a line of six large three-masters, plying between Portland and the cities of Chili, Australia, Russian Siberia and China. That is the way of the Oregon lumber trade, and yet they need engineers capable of systematizing and economizing their work in every department. The fact is that there is so much for every one that high competition as exists in the east is not felt here. An intense rivalry exists, however, between the cities on the Sound (Puget Scund) and Portland, and at present we are far ahead.

In telephone work, I must say that here we are behind the east, even the Potsdam service. There are two companies in this city, one of them using automatic phones; yet neither of them is entirely satisfactory to the people. A man could work either up to the proper efficiency by joining the companies and introducing a proper system, and be assured of pushing to the top in a very few years.

Structural steel work has come down upon the city like a flock of birds in the night. In almost every third block, the dark skeletons bar the sky view. Concrete is likewise a favorite building material, and together, they form a most promising and growing field for constructive engineering.

Structural steel work in business blocks is a new thing here, and the people marvel at the skyscrapers going up, twelve stories at present being the highest, that of the Wells Fargo building, just finished.

Electric trolley lines to suburban towns every day reach out their tentacles to new villages and enliven the country, simultaneously furnishing work for all branches of engineering.

I find it a mistake to specialize in school. At one time I did not believe in this. But since coming across so many young technical

graduates here, who are narrowly prepared and do not seem to get along, I have changed my opinion. One especially I know, who earns only $2.00 per day. They all wonder what is the matter with them. In real life a fellow has to grab whatever line of work he can get and do. The young man I have referred to tries to pose as an hydraulic expert, and having always confined his attention to this line, he cannot do any of the work in a dozen other openings that arise in his path, consequently he is not prosperous. Another thing I find, is that many of the men from the large schools, have somehow slipped through, as it were, and cannot come up to the man from the smaller college. This is due to their attending large classes where they cannot ask questions, where the education is for the class as a body and not confined to the development of the individual. The condition of the college graduate referred to cannot be due to any lack of experience, much less of intelligence. He has been out of college three or four years and served in the United States Reclamation Service in several states, but was given an unlimited leave of absence.

The educational work here offers also another field in which a mark may be made. It stands in need of a general shaking up and reorganization in the Northwest. The aspect of the environment strikes me as possessing a great deal of the lumber and money tints, and too little of the educational blue. There are many so-called practical people and few scientists. Degree-conferring courses at a minimum are of two years' duration. The curriculum, from my chats with the graduates, is incomplete as to college work, and overstocked with high school subjects. One day I passed through a large steel foundry with an engineer, B.S. in Engineering, '07, from a University west of the Rockies. He asked me all kinds of questions about things which, it seemed to me strange, he did not know himself. Upon questioning him, I found that he had never studied Chemistry. But he knew much of Latin, only one instance showing the requirements for degrees in this state. He explained that there was no higher supervision of the college work than that of the Faculty. That is to say, the schools of Oregon are independent of each other and may adopt various requirements for their diplomas and degrees. There is therefore a large work to do hereabouts in education, for teachers and professors are hindered only by the usual question of salary.

In closing I would like to be able to bring vividly to the minds of my old brethren in arms, and fellow-brethren in-mental-gymnastics, the beauty of Portland, the Rose City of the Northwest: views embracing mountain, forest, valley and stream. Four snow-capped peaks stand about the city like sentinels. From Mt. Hood, sixty miles away, comes the water used by the city, cool, limpid, ice-water from the base of the glacier which rests upon its sides.

Most noticeable is the lack of that wrinkle-begetting care found among the creatures of too-much-hurry in New-York-existence. This is replaced by a natural, healthy life, with plenty to do betimes during the day, to keep in good fighting trim; and a chance for refreshing sleep storing up enough energy to start anew next morning. People enjoy living here. It is shown in their complexions and the athletic build of the men. In the west the engineer is the man and the master of the machine; in the east he may become its slave.

My friend of the Weather Bureau tells me that the average rainfall of the city is 46.8 inches. From the logbook I find that since ar-

riving here, July 1st, the temperature went above 90 degrees only three times, and that the lowest has been only 53 degrees thus far. It is October, and yet the roses bloom along the sidewalks; the beautiful gardens around every man's house show that the town is well called the Rose City. Next June, $100,000 will be spent on the annual Rose Carnival.

Like Potsdam, Portland has beautiful streets, and fine, homelike private houses, very little hotel life and no apartment-hotels that I know of. That type of metropolitanism found in the east and in Europe, due to an artificial, burdensome, and unhealthy striving after notoriety and class distinction, is here fortunately wanting. Americanism is found in abundance. Frankness is cheap, being widespread, as may be noted from the universal contempt of resorting to diplomacy when the people wanted to chase the Japs and Hindus out of the country. Take it all around, this is a very good place to make a base of operations, and from which to strike the two and three baggers of one's life-work.

On the Pacific slope we are right on the fringe of civilizations, the Eastern which is to the Westward, in China; and the Western which is found Eastward on the Continent. The Star of Empire of the Caucasian civilization has reached its western limit. From the peoples now on this coast is to come the vanguard of the Great White Movement. Here we are destined to receive the brunt of the conflict of civilization. This in itself is intensely interesting, and even now exciting to an unfortunate degree out this way.

With a triple drum roll and a high flourish from the bugles, I now dip the ensign to you all. Should any Clarkson Tech. man make this port in the course of his voyages westward, he may be sure of good pilotage, and a secure mooring berth, by signaling the United States Navy Department outpost here in the Custom House.

THE CLARKSON ENGINEERING ASSEMBLY.

By C. Leo Hinds, '08, Speaker and Chairman of the Lower House.

The Clarkson Engineering Assembly is an organization composed of Faculty, Alumni, and Student representatives. It was chartered by the Regents of the University of the State of New York, May 29, 1907, ot transact business with all powers, privileges, and duties for a corporation of this character.

The inception of the Assembly idea dates back about two years, to the beginning of the session of 1905-1906. At that time plans for a decennial celebration were being talked over by the Faculty and the Alumni. It was proposed to make of the celebration as great a success as possible. It was therefore deemed necessary that everyone connected with the Institution should take some part in it. Accordingly each class was requested to elect two members to serve as a committee which, in co-operation with the Faculty, would plan and carry on the celebration. This was known as the Decennial Committee. The next step was to ask the Alumni Association for representatives. This was granted and the officers of the Association were chosen.

Such a representative body of all of the active forces of the Clarkson Tech. at work, then proposed to form a permanent organization

which in the future should have charge of all similar functions of the school. Not only in this respect, however, but in others, it was deemed expedient to develop the idea, and include in its workings the general welfare of the school community, and mutual inter-relations of Faculty, Alumni, and students.

On Decennial Founder's Day, November 30, 1906, the first annual meeting of the Clarkson Engineering Assembly was held, at which time the Constitution was adopted. The following preamble to the Constitution will best explain the object for which the organization was formed:

"We, the Faculty, Alumni, and Students of The Thomas S. Clarkson Memorial School of Technology, in order more efficiently to promote the advancement of Science, the dignifying of labor and increase of good learning for which this Institution was established; to form a more perfect working union of all working forces, and promote the general welfare af this Institution; and further, to aid its growth and development in accordance with the wishes and purpose of its Founders for the promotion of the best interests of men, and for the glory and praise of God, do establish this Constitution."

The Constitution provides that there shall be two branches of the Assembly, known as the Upper and Lower House respectively. The Upper House is composed of the Faculty and members of the Instructional Force, and eight members of the Alumni Association. The Lower House is composed, at present, of two representatives from each class in school. An amendment lately made provides that each class shall have three representatives, making twelve in the Lower House, so that the membership of both houses is more nearly equal. The Upper House, outside of the Alumni representatives, consists of thirteen members.

The right of the initiative and of the referendum are fully provided for. Resolutions or propositions may be introduced in either house, but before becoming operative or effective must be passed by a majority of both houses, and thence handed to the Director of the School, who is ex-officio President of the Assembly, to be signed by him, or otherwise returned with his objections to that house in which the measure originated.

The Constitution also provides that the Assembly shall in no way interfere with any of the rights vested in the Board of Trustees of the Institution by the laws and ordinances of the University of the State of New York, under whose charter this School of Technology is incorporated.

This presents a brief outline of what the Assembly is. It shows that to a certain extent its organization is patterned after that of our State and Federal government. The people of each district are, in the state legislature represented by their respective assemblymen, and in the federal halls by their congressmen, who are supposed to look after their interests to the best of their ability. If any public work, improvement, building, or other act relating to the general welfare of the people, is required in their particular districts, it is upon their representatives that they must rely to work it up and develop the matter for them.

In much the same way the students of every class have their part in promoting the general welfare and in the government of the Institution, through the representatives elected by themselves. When

they think it best for the interests of the School to have new measures considered and adopted regarding any class, organization, or other interests of the school community; or when one of their numbers has had any difficulty in relating himself to the life and work of the School, they instruct their representative to bring the matter before the Assembly, or a committee of the same, for consideration. If it is a legislative measure that is deemed necessary or wise by the Assembly, it is to be passed by both houses; if not, one or the other or both houses may reject it.

Before any act or meausure becomes effective and binding it must therefore have been made satisfactory to both students and the faculty, for otherwise at least one house would not have passed it. This eliminates the possibility of all unjust or objectionable rulings being passed by either house. It also insures peace and stability of the Institutional life of the Tech., and its government, with frank and reasonable consideration of any proposed steps on the part of either the Faculty or the student body.

In other words, the organization of the Assembly places students and Faculty on a level. In a helpful and co-operative way it makes it possible for them to work for the best interests of the Clarkson Tech. At the same time it enables them to carry this work forward with the co-ordinate administration of the Faculty. It likewise ensures a due regard and respect for the rights, privileges and imunities of every individual member of the school community. Each comes to consider himself a working unit in the organization of the School, with his relations to it, for the time being, fixed by the nature of the environments and character of his work.

The Assembly promotes the best feeling among the students. It aims to develop their character as men and their responsibilities as engineers. It recognizes ability. It seeks to govern judiciously, with as much consent of the governed as it is possible to obtain, consistent with the relations of teacher and taught. It secures confidence in the honor of every member of the school community, and promotes the manliness to do what is right.

The Upper House corresponds in a measure to the senate of our national government. Each state has an equal representation, although appointative members. In the Upper House the Faculty and Instructional Force are appointed by the Board of Trustees. Each department of the School is thus equally represented. The professor in charge has the interest of his particular department at heart. If propositions pertaining to it are introduced he will certainly follow them up; and if objectionable, seek to revise them, or, otherwise to welcome them. It is his duty to point out and suggest such amendments to proposed measures as will be most satisfactory to all.

The Alumni, likewise, have their elective representatives, eight in all, in the Upper House. In all propositions, therefore, affecting their welfare as well as that of the students, they will have equal voice and vote.

The Clarkson Engineering Assembly is thus seen to be a complete organization of all of the forking forces of the School. By its charter it is a corporate body, empowered to transact such business as is necessary to satisfy its needs and conform to the purposes had in view in its organization and incorporation.

Though the Assembly is still young it has undertaken a number of important propositions. The first was the successful planning and carrying out of the celebration of the decennial year. This required much thought, time, and work, for the celebration was not only that of a day, but included several public functions and commemorative exercises, connected with the School during that year, as Founder's Day, Charter Day, etc. The result of this work alone was sufficient to justify its existence, and to show of what material the Assembly was composed.

A further important proposition is the gymnasium. Its activities regarding this is but another example of what may be done. It brings out one of the primary objects for which the Assembly was formed, that of promoting the welfare of the entire student body, and such as that for which the School exists. The gymnasium will provide the means of promoting the physical development and betterment of every student. It is a means to another very desirable end in that it will help the Tech; providing a place where athletic teams may be suitably trained, and thence finally to aid in bringing honor and glory through greater assurance of victory in the field.

The gymnasium though long on the way is surely coming. It has had a proper start. A substantial gymnasium fund is now in existence and is steadily growing. When it reaches the five thousand dollar mark it will be doubled by Miss Lavinia Clarkson. Thence forward, work will be going on towards construction. For some time past the plans and specifications have been completed by the architect. The gymnasium will be the property of the Assembly and will be directly under its control. This is made possible through its charter which grants it such a right to own and manage property, in its interests as a corporate body.

These are only a few of the many important matters which have arisen and have been taken in hand by the Assembly: It is quite clear that with such an organization of Faculty, Alumni and students, much more difficult problems may come to be similarly treated.

We, the students, feel that this is our Assembly. In it we have voice and vote. Through it we may exercise the right of initiative and of the referendum. We are prepared to defend its Constitution and to stand by its charter. Through its instrumentality we may promote the advancement of science and of the useful arts; and aid to the utmost in developing the work of the Clarkson Memorial, in accordance with the wishes and purposes of its Founders.

THE YOUNG MEN'S CHRISTIAN ASSOCIATION.

By Grant Tracy, '08, President.

The Association is now well started on its fourth year, and a larger percent of the student body is represented in its membership than ever before. During the past three years of its existence in the Clarkson Tech., the influence which the Association has brought to bear upon the life and work of the Institution has been marked and salutary. The increased attendance upon its meetings and the activities of its members have shown it to be here as elsewhere a most worthy and wholesome feature of college life.

The Young Men's Christian Association of the United States and Canada will this year receive more efficient direction than heretofore, owing to an increase in the number of field officers.

Summer conferences are held each year for the purpose of bringing the representatives from the various colleges into closer touch with association work. These conferences are conducted by such men as John R. Mott, Robert E. Speer, G. Cambell Morgan, and others of equal success in work for young men.

The convention held at Northfield, Mass., is especially devoted to the college men of the Eastern States. This convenes as soon as the colleges are closed for the summer vacation. It seeks to give those who attend a ten days' vacation, one of recreation and enjoyment, as well as one for special training in the study of the Bible, and in spiritual uplift. The aim of the Clarkson Y. M. C. A. is to send delegates annually to the Northfield convention who will both help and work up the Association in the Tech.

The ambition of every Clarkson man is to prove himself worthy of recognition and promotion, to assume positions of trust and responsibility. The Y. M. C. A. in the college aims to assist students in laying such character-foundations as shall prove of permanent value in after-life. Moreover, it develops stability of character, so essential to the success of the college-bred man as an individual, and of equal importance to the general welfare of society and the preservation of the State.

All members of the School Community are cordially invited to attend the regular Friday evening meetings of the Association. These are held in the Chapel Hall of the School, and have proved in every way beneficial and inspiring to all who have attended.

Y. M. C. A. Topics, I Semester—1907-1908.

Sept. 20—Supplied.

Sept. 27—The necessity of abstinence in acquiring fame. Deut. 29:6. H. M. Merriman.

Oct. 4—The Gospel of Jesus Christ essential to the advancement of civilization. Acts 10:9-20. Hardenburgh.

Oct 11—Supplied.

Oct. 18—Our resources administered not by impulse but wisely. II Tim. 2:15. L. W. Weed.

Oct. 25—Tests of character. Jas. 1:13-15. Rodger.

Nov. 1—The duty of confessing Christ before men. Matt. 10:32-33 Willson.

Nov. 8—Account shall be made of idle words. Matt. 12:36-42. Tracy.

Nov. 15—Nobility of character. Corwin.

Nov. 22—Our business in the world. John 20:21; II Cor. 8:9. C. S. Merriman.

Nov. 29—Human instrumentality is useless without God. I Cor. 36:7-9; Acts 15:4. Moulton.

Dec. 6—God promises his co-operation. Phil. 2:13. Maynard.

Dec. 13—The value of friendship and how to maintain it. Prov. 18:24. W. W. Weed.

Dec. 20—Supplied.

Jan. 3—Serving by example (1). Matt. 5:13-15; I Pet. 2:11-12; I Cor. 8:10-13. Merrill.

Jan. 10—Serving by example (2). John 13:35; Phil. 2:15; I Tim. 4:15-16. Merithew.

Jan. 17—Self-mastery. I Cor. 9:19-27; Prov. 16:32; Matt. 5:43-48 H. R. Jones.

Jan. 24—Public affairs a Divine trust. Rom. 13:1-7; Dan. 2:20-21; I Pet. 2:13-17. Kendall.

THE CLARKSON ATHLETIC ASSOCIATION.

By Rufus L. Safford, '08, President.

The annual meeting of the Association was held, Monday, October 14, 1907, for organization and the election of officers. The Athletic Council is composed of the Chairman of the Athletic Committe of the Faculty, the President and the Treasurer of the Association, and one member from each of the four classes. The Council has general supervision of all athletic sports and contests, passes upon eligibility of players, arranges the schedule of games, and seeks to foster honesty and fairness in all athletic sports.

The Association has put no football team in the field this fall, but instead intends to put its money and its energy into next season's base ball team. With so much good material in the Clarkson Tech, there is no question now but that a winning base ball team can be turned out in the spring.

Owing to the lack of gymnasium facilities there will be no basket ball team this season. Last year a sum of money was partially raised for the construction of a gymnasium with the idea that possibly the building would be erected during the year 1907. Not a sufficient amount of money was raised, however, to begin operations this year, although the plans and specifications were ready at Commencement, last June. It is necessary to wait until the required sum of five thousand dollars is raised by the Alumni, Faculty and students, in order to avail ourselves of the equal sum of five thousand dollars offered upon this condition by Miss Lavinia Clarkson. The gymnasium building fund is now so near one thousand dollars ($975.11) that there is every prospect of securing the necessary balance, so that by Founder's Day, November 30th, 1907, we shall have raised our first thousand of the amount guaranteed a year ago on the Decennial Founder's Day. This is where the gymnasium project stands today. The Tech. greatly needs this gymnasium. Nothing can take its place in the training of our men. In fact, it is an imperative necessity in every modern college. Engineers to be worthy of the name must have sound and healthy bodies. Young men may go through the Clarkson Tech. as it is today, may absorb all the knowledge that it is possible for a human being to acquire, in the four short years of college life, and yet, when they are through with it all what can they endure as an engineer? For there is no profession akin to engineering, save the military, that calls so persistently for training in the power to hold on, the capacity to endure. Brains without brawn, mind without body, are of little use in the training and work of men for engineering achievements.

Our students have no such opportunities for thorough, systematic, and well-directed physical exercise, as all enlightened men now recog-

nize as an educational necessity. Otherwise, they develop their minds at the expense of their bodies. Such a plan will not do at all for an engineering college. Its graduates must stand all sorts of hardships and privations. They must take these as a matter of course, as a part of their daily work. To turn out successful athletic teams it goes without saying that we must have a gymnasium where all of the men may work and train through the winter months so that they shall not go out of doors, when spring opens up, with soft and flabby muscles. It is what is done in this period, between the close of the foot-ball season and the opening of the base ball season, that tells most effectively in college contests.

The Tech. must and is going to have a gymnasium. Every member of the school community is working for it. The project is bound to succeed. The plans that have been drawn up by Mr. Edgar A. Josselyn, of New York City, the architect, are for a first class gymnasium in every respect. It will be in proper architectural harmony with the present building of the Clarkson Memorial. No one would rest satisfied with less, nor would anyone expect more than this. The gymnasium should come up to the building contemplated in the plans already exhibited. If all of us, Faculty, Alumni, and Undergraduates. work this year as we did last year, we shall see "something doing" before many months, and build a gymnasium of which every one interested in the Clarkson Tech. will be justly proud.

THE TECH. CONCERT.

Glee Club and Orchestra Give a Fine Entertainment.

An appreciative audience enjoyed a rare treat Friday evening, Oct. 18, 1907, in the Chapel of the School at the concert given by the Tech. Orchestra and Glee Club. The soloists, Miss L. A. Cummings, soprano; Mr. L. H. Sisson, '10, baritone, and Mr. S. A. Clute, '11, cornet, rendered their numbers excellently.

Miss Cummings has always been a favorite and her voice was even better than ever before and her numbers were beautifully sung.

Mr. Sisson sang "Love's Springtide" in a charming manner.

Mr. Clute's cornet solo brought a round of applause, and he was obliged to play an encore, "Love Me and the World is Mine." The School is indeed fortunate in having Mr. Clute. His playing demonstrates him a first rank performer.

The Glee Club sang a college song with characteristic vim.

There was one number, a selection from the recent "Gingerbread Man," interpolated in the program of the concert, and the four numbers played by the Orchestra showed finish and good selection. The overture from the "Bohemian Girl" indicated rare talent and brought out the best results of the Orchestra. Miss Charlotte Whitton at the piano ably seconded the soloists and supported the orchestration numbers.

The Welker Brothers, '09, managers of the Clarkson Tech. Orchestra and holders of Musical Scholarships 1906-1907 and 1907-1908, are to be congratulated upon the success of the Orchestra and the concert. The program was as follows:

Program.

Selection—Grand Mogul... ... ...Luders
Orchestra.

Vocal Solo—"Love's Springtide,"... ... ...Hammond
Mr. L. H. Sisson, '10.

Overture—Bohemian Girl... ... ...Balfe
Orchestra.

Vocal Solo—"Slumber Song,"... ... ...Dietrich
Miss L. A. Cummings.

Cornet Solo—Elite Polka... ... ...Boardman
Mr. S. A. Clute, '11.

Selection from "The Orchid,"... ... ...Furth
Glee Club.

Finale—Red Mill... ... ... Herbert

Too much cannot be said of the Clarkson Tech. Orchestra, whose work was highly appreciated. It is a student musical organization consisting of ten members, who furnish the music for the several special exercises and commemorative occasions of the School, the Chapel exercises, and a series of Musicales to the School Community. A competent director, experienced managers, an excellent outfit of orchestral instruments, and an up-to-date repertoire of the standard musical selections have been provided, forecasting an upward growth in the musical department.

THE GYMNASIUM BUILDING.

A meeting of the Gymnasium Building Committee was held in the Library of the School, immediately after the reception, following the commencement exercises, June 14, 1907. All resident members were present, and Messrs. Lawrance, Harriman and Perkins, alumni guests. The full set of plans and specifications were presented, as prepared by the architect, Mr. E. A. Josselyn, of New York City. The plans had earlier been laid before the Assembly. It was decided to lay them before the Board of Trustees and the Alumni, that all interested might see the character of the work taken in hand by the Clarkson Engineering Assembly.

The sum of money raised on the Gymnasium Building Fund, by Alumni, Faculty, and Students, is $975.11. It is expected that this will be brought up to one thousand dollars, by next Founders' Day, November 30, 1907, which will then be placed on interest and all efforts bent toward raising the second thousand. The conditions to be met were announced at the close of the evening reception, in the Library of the School, following the Decennial Founders' Day Exercises, November 30, 1906. These were to the effect that Miss Lavinia Clarkson, one of the original Founders of the School, would subscribe five thousand dollars towards building the gymnasium if an equal sum should be raised by the Alumni and the Assembly; whereupon the Alumni guaranteed to raise three thousand and the Assembly two thousand dollars of the required amount.

THE SENIOR CLASS.

By Charles Stephen Merriman, '08.

Three years of our college course have now passed and the fourth and last year is well under way. Those first three years passed quickly enough, with a little pleasure, and some may think much work, Having thus passed almost all of us would leave the years to their reckoning, while we look forward to the future and to what it may bring us.

The future is the all-absorbing topic in the mind of a Senior. To it he looks by day and dreams of it by night. When we entered as freshmen we thought that if once we were seniors all our troubles and work would end with taking on the dignity befitting a senior. Our one ambition, therefore, was to become seniors. Now that we are seniors, what do we find? We see that the world goes on just the same, and that we must set up a new goal and a higher standard toward which we must strive, or be left in the rear. The goal lies somewhere in the future, in the outside world into which we will soon be ushered as young engineers.

When the present senior class entered the Clarkson Tech. it numbered thirteen, which was somewhat smaller than the average class of that time. Although handicapped by lack of numbers, the class has held its own remarkably well, both on the field and in the lecture room. We succeeded in holding our own also at the freshman banquet, and defeated the sophomores at base ball.

Our sophomore year saw thirteen men in the class; eleven, however, being of the original thirteen. We were at this time well organized as a class and held our own against the incoming tide of freshmen. Our time was nearly all taken up with study. Yet we found opportunity for a little diversion now and then.

Our junior year was somewhat like the sophomore year, with possibly less time for recreation. We started the year with thirteen members. Thirteen is not esteemed a lucky number, by the superstitious, yet the class remained intact to about the middle of the year when it dropped to eleven. The principal event of the year was the Junior Prom which, owing to our small numbers, came rather heavy on our pocket-books.

This year we have eleven men in the class, nine of the original thirteen being still enrolled with us. Five members are taking the course in civil engineering, four in electrical engineering, and two in mechanical engineering. Naturally we do not look for any further decrease in our membership, though some may consider it providential that they are nearing the end of their course.

A fortunate circumstance connected with the senior class is the large percentage of its representation in the Clarkson Engineering Assembly. Seven out of the eleven in the class are members, four by reason of being on the instructional force of the School through holding scholarships, are in the Upper House of the Assembly, and three are representative members by election, to the Lower House.

To a certain extent it has been quite the same with our class as with all other classes that ever reached the senior year. It is a case of the survival of the fittest. There are a few, however, of our original membership who have passed out from time to time by reason of

the prosepcts of immediate income. The chance offered by a good position seemed more attractive than an engineering degree in prospect

Those among us who remain feel that there is yet something to be done, that there is work for all, and that the demand for Clarkson men is such that we need not fear that we shall lose the job if we are not on hand nine months ahead of time. We will surely be given the chance of all Clarkson graduates to put what we have learned to practical use in the future, which with all of its opportunities, is still before us.

THE JUNIOR CLASS.

By Hervey N. Scofield, '09.

The class of '09 returns this year to find eleven of its old members returned, and two new members, graduates of St. Lawrence University, entering to pursue the civil engineering course. Six of the others are taking this course and five are taking electrical engineering.

The class has passed through the trials and tribulations of freshman and sophomore years. It now starts in, on the last two years of real engineering work at the Tech., with the same spirit of determination to achieve its aims and ambitions which it showed when, as a freshman class, it carried through its class banquet without interference, tied the sophomores in football, and won the interclass base ball game, thereby establishing a new precedent for all entering classes. In scholarship the class has shown itself to be up to a high standard.

We have lost nine members since we entered the Tech, and gained two, as above stated. Rushton and Wellington are looking after the almighty dollar. Van Horne is basking amid rural surroundings, and contemplating a course in forestry. Young has a position with New York State and expects to return to the Tech. next fall, to complete his course for the degree. Eastman is on the Pacific coast for his health and other reasons. McNulty, our versatile bard, scout and all-round handy man, is a nautical expert, directing tides and currents and warding off earthquakes for the U. S. on the Pacific coast.

The remainder of the class is here and we settle down once more to our work with that feeling of real comradeship between us which only the close associations of two years in such an engineering college as the Tech. can give. We have shared the play, the hopes and fears, and the work and the joys of college life, and now look forward to two more years at the Clarkson with a feeling of confidence born of experience and anticipation based upon results achieved. High hopes are entertained that when in the course of human events it becomes necessary for us to leave our Alma Mater and be freshmen again, in a very real world of work and affairs, we shall acquit ourselves like men and prove worthy of Clarkson spirit and Clarkson ideals.

THE SOPHOMORE CLASS.

By Lloyd W. Weed, '10.

Our class entered the Tech. with twenty-eight members. We were at that time the largest class in the history of the Institution. Inthe freshman year we enjoyed many more liberties than are usually allowed the entering class, not only on account of our numbers, but also to a great extent owing to the absence of "freshness" and "greenness" by which all freshmen are usually known. Although we were not very successful in athletics, due to the exceptional ability of the class of '09, we made a good showing in all other lines of work.

As to the various lines of college life, we entered into the spirit of every occasion of revelry last year, and hold ourselves ready to do so now. Socially, the class of 1910 stands preeminent. When dances and balls beckon to us, we go and are received with acclamations and open arms. It is well known that we add to the pleasure and entertainment of every occasion. In the deliberations of the Clarkson Engineering Assembly we have influence. When the students were called upon to subscribe towards building the Clarkson Gymnasium, our class responded nobly and stands first in the list of subscribers.

This year we returned with twenty-six of our former members, the largest reassembling of the Old Guard that we have ever heard of in the annals of the Clarkson Tech. Although greatly outnumbered by the incoming students, we performed the Sophomoric duty of showing the freshmen their places and standing in the community.

The sophomore class is usually looked upon with suspicion and mistrust. A bonfire lighted in one part of the town, a rail fence missed in another, an orchard visited in the dead hours of the night, a laundry box lost, a school bell fails to ring in the morning! Who are blamed for these acts of vandalism? The Sophomores. Ah, but those who condemn this noble class are sadly mistaken. They do not know the class nor the work which they must do. Ask any sophomore where he was on that eventful night. He will say, "I was home, studying far into the morning hours, struggling with physics, calculus and analyt." The present sophomore class has done its best to uphold the reputation of its predecessors and will continue to do so.

We are here not for rest and recreation, but for work, to prepare for our life vocation, to learn to be engineers. While we are here we will uphold Clarkson's honor and Clarkson's reputation.

May all Clarksonians say with us:

"Here's to Clarkson,
May her future be ever bright.
Here's to workmen
Standing loyally for the right!"

THE FRESHMAN CLASS.

By R. D. Kendall and G. D. Cowie, '11.

The Freshman Class, proud of its attainments, its numbers, and its early victories, are glad to give the public a modest account of the opening of its life at the Clarkson Tech. We admire the social instincts of the sophomores, which prompted them during the first week of our sojourn here, to pay us calls, rather too late in the even-

ing. We thank them for their kind offers to guide us to the "fount-tains of inexperience." We are sorry, however, that "Sud" was the only man to avail himself of this liquid opportunity. We promptly returned the compliment by inviting "Mac" to refresh himself in the soothing waters of the Racquette.

On Saturday night of the same first week, the aforesaid sophomores placed about the streets certain rules and regulations for our future conduct. But we disdained to accept such childish advice and immediately destroyed them. Early on the Sunday morning following, we put down a new set of rules which, if followed, would have made the sophomores models of young manhood. Also, on the same morning we met them by the riverside in a hard fought scrimmage.

Soon after this we held a class meeting and elected Michael Regan President, and made arrangements for our banquet. It was held on Thursday evening, September nineteenth, at the Albion House. As the sophomores attempted to break it up by climbing through the window, we succeeded in securing three of them. These we bound, hand-and-foot, and gave them a place in the corner, to please our friends, the sophomores, who were waiting outside. The proprietor requested us to omit our toasts, and we adjourned to the open air with our victims. Here we received the remaining sophomores and escorted seven of them to the river.

In the course of a few days we gathered from our valorous ranks a foot-ball team which has done us credit. At the first call, a large number of candidates turned out and went to work training with a will. Almost all of them had played before, so that it was only necessary to drill in signals and unity of action. In a short time we had a team which, though light, was fast.

Our opening game with the Normals was a draw, although it was generally conceded that we had the better of the contest. The Saturday following we played Massena, on their home grounds, suffering the first and only defeat, by a score of 6 to 5. During the second half a Massena player seized a fumbled punt and ran through a clear field for a touchdown. We also made a touchdown in that half, but failed to kick the goal, thereby losing the game.

The following week we went through hard practice for the Freshman-Sophomore game, scheduled for Saturday, October nineteenth. Throughout the contest we showed superior knowledge of the game, often ploughing through the opposing line for big gains. By steady line-bucking and short punts we rushed the ball to within a yard of the sophomore goal line but failed to go over. For the remainder of the half the ball passed back and forth, neither side scoring. In the second half we "dug in" and after ten minutes playing, scored the only touchdown. We are especially proud of this victory, as it is the first time in the history of the Tech. that a freshman team has defeated a sophomore team on the gridiron.

We wound up the season by a return game with the Normals. This was a harder game than the former, but we made good, scoring one touchdown and winning the game by a score of 5 to 0.

Here's to the Class of Nineteen-eleven! May they continue their good work and do honor to the Clarkson Tech!

Clixie, Clarxie, Clixie, Cleven,
Clarkson, Clarkson, Nineteen-'leven.

ASSEMBLY AND STUDENT ORGANIZATIONS.

CLARKSON ENGINEERING ASSEMBLY.

Organized, January 19, 1906; Constitution adopted at first annual meeting, Decennial Founders' Day, November 30, 1906; granted Limited Charter by the Regents of the University of the State of New York, May 29, 1907.

Board of Trustees.

Elected November 30, 1906.

To serve for one year: Charles A. Pohl, '02; Floyd R. Finch, '07.
To serve for two years: Prof. Donald F. McLeod; G. A. Stebbins, '01.
To serve for three years: Profs. F. M. Williams, B. B. Brackett.
The Director, Ex-Officio, Chairman and the seventh Trustee.

Upper House of the Assembly.

The thirteen appointive members of the Instructional Force: Wm. S. Aldrich, Frank M. Williams, Byron B. Brackett, Carl Michel, Donald F. McLeod, Wm. M. Towle, Wm. A. Yerzley, Samuel G. Barton; John J. Grieb, '08; Rufus L. Safford, '08; John J. Schrodt, '08; Hugh M. Sprague, '08; Bryan W. Morse, '09.

The eight elective members of the Alumni Association: George A. Stebbins, '01; Wm. J. Fox '02; Rea M. Gordon, '02; Charles A. Pohl, '02; Burton L. Delack, '03; F. C. Zapf, '04; Lloyd W. Greene, '05; M. L. Stack, '05. Total, twenty-one Assemblymen.

Officers, 1907-1908: President, the Director, Wm. S. Aldrich; Vice-President, Professor Frank M. Williams; Secretary, Bryan W. Morse, '09; Corresponding Secretary, F. C. Zapf, '04; Treasurer, John J. Grieb, '08.

Lower House of the Assembly.

Seniors: C. Leo Hinds, J. P. Lynch; Juniors: Lee W. McCullough, George E. Welker; Sophomores: Conrad V. O'Malley, Lloyd W. Weed; Freshmen: George D. Cowie, Charles B. Garvey. Total, eight Assemblymen.

Officers, 1907-1908: Chairman, the Speaker, C. Leo Hinds, '08; Secretary, Lloyd W. Weed, '10.

YOUNG MEN'S CHRISTIAN ASSOCIATION.

Grant Tracy, '08,... ... ... .President.
Hervey N. Scofield, '09,... ... ...Vice President.
Lloyd W. Weed, '10,... ... .Secretary and Treasurer.

CLARKSON TECH. ORCHESTRA.

Sherman A. Clute, '11, Director.
John A. Remington, '11, Secretary; Woolsey W. Weed, '11, Treasurer.
Loy E. and George E. Welker, '09, Managers, and holders of the Musical Scholarships, 1906-1907, and 1907-1908.

CLARKSON ATHLETIC ASSOCIATION.

Rufus L. Safford, '08, President; George McG. Rodger, '09, Secretary; Valier Mayhew, '09, Treasurer; John J. Grieb, '08, Baseball Manager; Conrad V. O'Malley, '10, Assistant Baseball Manager.

THOMAS S. CLARKSON
MEMORIAL
SCHOOL OF TECHNOLOGY
POTSDAM N. Y.

This Institution was founded in 1895. It was chartered, March 19, 1896, by the Regents of the University of the State of New York, and opened its doors to students in September of the same year.

The object of the Clarkson foundation is to provide technological education of college grade.

The School is located at Potsdam, St. Lawrence Co., N. Y., on the Rome, Watertown and Ogdensburg division of the New York Central Railroad. It may be reached from all points through the connections of this road in New York State and Canada.

For admission there is required a thorough four year high school preparation. The regular courses extend over four years and comprise instruction in language, literature and history, mathematics, the natural and economic sciences, engineering and technology. The instruction is largely taken in common, during the first two years, and provides the elements of a liberal education. Based upon similar instruction in the fundamental principles of the applied sciences, the subsequent training aims to develop the habit of clear and accurate thinking, familiarizing the student with practical methods of executing work and projects and scientific methods of conducting investigations.

The technical instruction of the last two years, in theory and practice, affords substantial preparation for immediate usefulness after graduation by intelligent application of principles to the successful mastery of the details of the chosen field of work. A foundation is also laid for those who intend, by further study, to specialize in some particular branch of their profession.

The four year courses in engineering afford thorough preparation for those who intend to engage in the professions of chemical, civil, electrical or mechanical engineering. They lead to the degree of Bachelor of Science in the major subject pursued; namely, chemical, civil, electrical and mechanical engineering. The degree of B.S. is conferred and certified by a diploma issued by the Regents of the University of the State of New York, jointly with the Trustees of the Thomas S. Clarkson Memorial School of Technology.

This School is included by the United States Civil Service Commission in the list of approved technical schools, diploma from which entitles the holder to promotion in the Engineer Department at Large; and in the list of accepted institutions entitled to share in the benefits of the Carnegie Foundation for the Advancement of Teaching.